LOS ANGELES
PUBLIC LIBRARY
Central

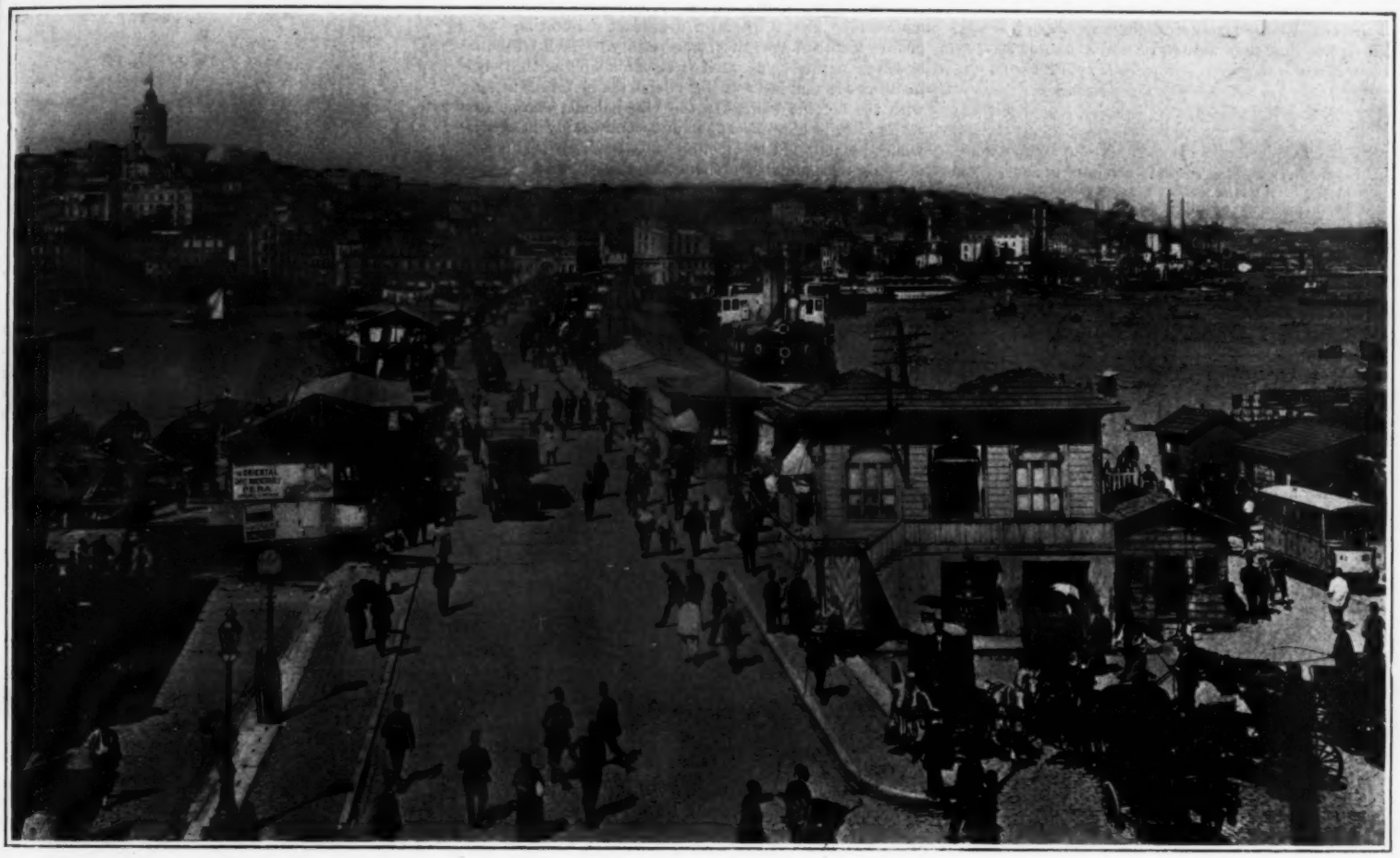
SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1913 by Munn & Co., Inc.

VOLUME LXXV]
NUMBER 1934]

NEW YORK, JANUARY 25, 1913

[10 CENTS A COPY
[$5.00 A YEAR



The Old Bridge.

The New Pontoon Bridge.

MODERN ENGINEERING IN AN ANCIENT EASTERN CAPITAL.—[See page 60.]

The Psychology of the Gambling Habit*

A Study of the Suspense in Gaming, the Drama, and the Experimental Sciences

By J. Leonard Corning, M.D., LL.D.

THE spell wrought in the mind by hazard is as old as humanity itself. Whether called into being by battle, the stock market, or the roulette table, the enchantment remains the same. When asked what were his emotions on the eve of an impending battle, an officer of distinction replied that they were "Precisely the same as those

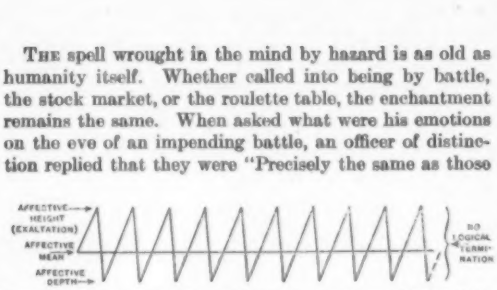


FIG. 1.—Diagram showing suspense curves in gambling. Note that the height is somewhat greater than the depth, and that there is no logical termination, the erethism continuing after cessation of play.

I used to feel when laying a tremendous stake." The essential similarity between the feelings aroused by strenuous stock speculation and those called forth by games of hazard has been frequently pointed out.

What is the underlying psychology of phenomena of this kind? Avarice no doubt is constitutional, as it were, with some persons, and this quite irrespective of their economic situation in the world. To such individuals the prospect of laying hold of their neighbor's possessions even at the risk of parting with their own, involves, to put it gently, a unique and considerable fascination. Were these and their congeners the only victims of the caprice of hazard, society could perhaps afford to let them go their way unmoved. Unfortunately, there are other specimens far from ignoble, many of them, though for the most part not less vehemently infatuated, who swarm about the gaming table.

What—since they are in many instances neither predatory nor yet very poor—what urges these people to the gaming table, and what keeps them there? Surely inordinate greed is not responsible for their coming, nor can it be held to be the sorcery which enchains them. Where, then, lies the witchery? Some writers have found the explanation in the excitement caused by the alternation of hope and fear. Nor can it be denied that this alternation is the important factor in games of hazard. Yet it is necessary to remember that still other forces are at work; that, in a word, we have to do not not only

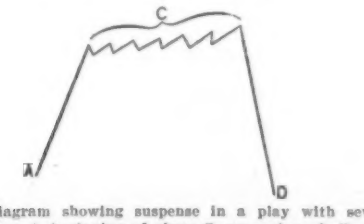


FIG. 4.—Diagram showing suspense in a play with several climaxes; *A*, beginning of play; *C*, succession of climaxes, arranged in rising gradation so that suspense is progressively increased; *D*, dénouement.

with hope, but fruition; not only with fear, but with loss and sometimes despair. Here the affective contrast is as wide as could well be imagined. And, as if this were not enough, the widely disparate moods, obedient to the capriciousness of chance, are, as already intimated, rapidly alternated, victory following defeat and *vice versa*, so that a new composite erethism is engendered, an erethism which knows neither respite nor repose. To help to an appreciation of what is here implied, the writer ventures to introduce a diagram. (Fig. 1.)

Is there any similarity in the manner of its production between suspense as it is met with in gaming, and suspense as it occurs in certain of the Arts—the Drama, for instance? A moment's consideration will show that in certain respects a resemblance of this kind is certainly traceable. Take melodrama—the old kind—replete as it is with thrills and "gory interjections." Here plot is everything, the delineation of character but a subordinate concern of the playwright. The sympathetic element represented, let us say, by hero and heroine, and the antipathetic by the villain, are aggressively apparent. There are no half people; all are either devils or angels. The hero desires the heroine in marriage; the villain feels the same way—entrance of the exciting force. Were the hero, however, to realize his wish too easily or too quickly, there would be little drama and less suspense. Obstacles, or subsidiary actions (machinations of the villian or his friends, etc.) are accordingly introduced. Thus by play and counter-play the action of the play is retarded, suspense is maintained, and excitement augmented. Neither the hero nor the villian is allowed the upper hand for long. For a space, the hero seems about to triumph; then down he goes, and up goes the villain. And so the process is repeated and the play progresses, arousing and maintaining in the spectator a kind of palpitating suspense—a sort of see-saw of uncertainty.[1] Such tension, however, nature being what it is, cannot be indefinitely maintained; and hence in due course the hero runs away with the heroine (climax); the villian being unable to catch him, is himself caught and comfortably hanged; while the hero and heroine, as befits the truly virtuous, are duly amalgamated (dénouement).

In an entertaining little book on the elements of dramatic construction, published more than twenty years ago,[2] Hennequin observes that "The most important means of arousing interest (in the drama) is suspense. Keep a listener in doubt as to what is coming, and he cannot help but listen. Suspense is the nervous system of the drama. In some form or another it must exist throughout the entire progress of the story. At various points of the story, generally at the close of each act, it may be

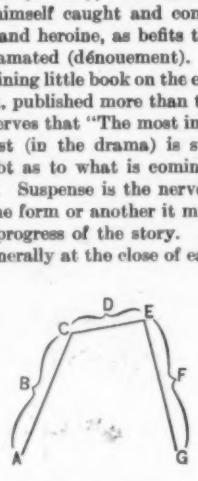


FIG. 3.—Diagram showing suspense in a play with two climaxes. *A*, beginning of play; *B*, *D*, suspense (*B*, play and counter-play to first climax *C*; *D*, play and counter-play to second climax, *E*); *F*, fall; *G*, close.

partially relieved; but it must always be done in such a way as to give rise to new suspense, or to leave one or two particulars still unsettled. Not until the last moment of the story should every item of doubt be cleared away."[3]

The appended diagrams (Figs. 2, 3, 4) show the management of suspense in plays of one or more climaxes.

While the morbid craving for a maximum of excitement with a minimum of effort, confirmed as it is by habit, plays a conspicuous—nay, the chief—rôle in the bewitchment of the gamester, it can scarcely be denied that abnormally emotionalized ideas of success exert at least a contributory influence. Hence the suspense curve of gambling is somewhat greater in height than in depth. (Fig. 1.) Confirmation of this view is afforded by the fatuous attempts of those who play for low as well as high stakes to establish a "system" or theory of the game whereby success shall be rendered more certain. To the average outsider, untrammeled by the fascination of gaming and alive to the impossibility of fore-reckoning the infinite vagaries of hazard, their efforts seem to betoken a singular obliquity of mind. This tendency to rationalize where premises are quicksilver and logic thrown away is a characteristic peculiarity of the gamester. Thence arise quixotic feelings of confidence, intensified, perhaps, by various superstitions, of which gamesters are known to cherish a variety; and these in turn tend further to increase the height of the suspense curve.

Among such superstitions, "Rouge et Noire"[4] gives the following: "To turn your back on the moon when playing for money portends ill luck; to lend money is unlucky; to play on borrowed money is unlucky; playing with money first laid on the altar Christmas night i-

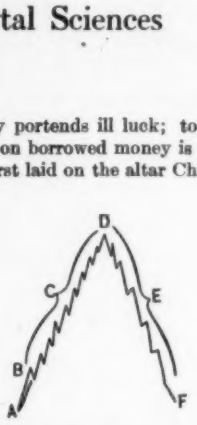


FIG. 2.—Diagram showing suspense in a play with a single major climax. *A*, beginning of the action; *AB*, exposition; *C*, growth (play and counter-play) suspense; *D*, climax; *E*, fall; *F*, dénouement.

lucky; some gamblers believe that they can cheat luck by going from table to table or playing at certain intervals. . . . The approach or touch of a hunchback is held to be a sign of luck." Among savages the belief in luck is apparently universal, and to gain its countenance they have recourse to philters, fasting, and an astonishing variety of ceremonious cajoleries.

Of contributory effect in heightening excitement in the gamester should be mentioned the magnitude of the stake, and the influence of its loss or gain on his welfare and future destiny. The importance of this element is obvious, and has been accentuated by even the most superficial writers on games of chance. Not so fully appreciated is the erethistic influence of a neurotic temperament. Over and above the predisposing rôle played by such a temperament in heightening the excitement of gaming, the present writer is convinced that to it are largely to be charged those more extreme manifestations of the gaming impulse that so frequently result in the permanent undoing of the subject and the humiliation and misery of his dependents. Still more disastrous is the craving when it develops in those already afflicted with some form of neurotic derangement. Danville and Sollier[5] have published two instances of this kind, in which the presence of a neuropathic element was easily made out. In the first, the impulse to play was comparable with an hysterical attack; in the second, with the morbid craving of dipsomania. Here, the passion to play assumes the dimensions of true mania

FIG. 5.—Suspense curve in a series of experiments undertaken for the solution of a major problem. There is no progressive rise (in suspense), the only increase in height being at the close. Failure would entail a corresponding fall.

the motiveless, irresponsible, and at times furious excitement of the subject impressing even those without psychiatric knowledge as essentially insane. It may be noted in this connection, that the gaming habit is not infrequently associated with paranoid conditions, a fact overlooked or but slightly accentuated by most writers.

From this commentary we may pass to the consideration of a group of activities in which, while at times there is considerable suspense, great demands are made upon perception, reason, inductive and deductive, and imagination as well. Nowhere are these activities more in evidence than in the experimental sciences, including invention and, to some extent, original work in the domain of astronomy and the higher mathematics. Is there anything at all comparable with the suspense so characteristic of gaming and that met with in those who devote themselves to these disciplines? With due allowance for temperamental differences, and excluding for purposes of comparison those pursuits which, while they imply some power to observe, require a minimum of interpretative subtlety, it may be granted that a certain degree of analogy is really traceable. That a long period of brooding and experimentation undertaken for the solution of a considerable problem may at times be accompanied by a high degree of suspense, is abundantly attested by the history of discovery and invention. Obviously the importance of the problem; the success and failure of the individual experiments undertaken for the purpose of its solution, and the rapidity with which one

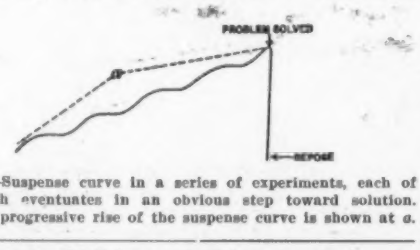


FIG. 6.—Suspense curve in a series of experiments, each of which eventuates in an obvious step toward solution. The progressive rise of the suspense curve is shown at *a*.

* *Medical Record.*

[1] For a more detailed account of how suspense is maintained in the drama, see "The Technique of the Drama," by W. T. Price, pp. 11, 34, 93, 94, 99, 122, 176. Brentanos, New York, 1897.

[2] "The Art of Playwriting," by Alfred Hennequin, Ph.D., p. 93. Houghton, Mifflin & Co., 1890.

[3] "The essential nature of the drama," observes Freytag, "is conflict and suspense. The sooner these are evoked by means of the chief heroes themselves and given direction the better." "Technique of the Drama," by Gustave Freytag, p. 100. Chicago, 1896. (Translation from the sixth German edition.)

[4] "Gambling World," quoted by Clemens J. France in his excellent paper, "The Gambling Impulse," the *American Journal of Psychology*, Vol. XIII, p. 391. 1902.

[5] *Revue Philosophique*, Vol. LXV, pp. 561-576. 1908.

experiment follows upon another, will largely determine not only the degree but, to an extent, the character of the emotional erethism. (Figs. 5 and 6.) But conceding this as a general statement, it is not to be forgotten that in a certain proportion of research work there will be time sufficient for more or less recovery from the excitement, pleasurable or painful, of each experimental venture; and time is an all-important element in the rehabilitation of the emotional mechanism. The suspense curve will, therefore, be undulating rather than abrupt.

It is precisely in this that the suspense of experimentation and invention differs so widely from that of gaming, in which so little time elapses between the separate coups that recovery, even to a limited degree, is impossible. Moreover, there is the further difference that in experimental work there is apt to be a definite conclusion; either the end is attained, or the problem is for the time being, or perhaps definitely, abandoned. A logical conclusion, as already pointed out, and consequently repose, is also attained in the drama; and there is besides a considerable lapse of time between the separate parts of the action. Nothing of the kind, of course, is possible in games of pure hazard; there is no logical sequence, neither are there any intermissions, and hence in the nature of things there can be no logical conclusion. That the inveterate gamester carries his excitement away from the table, has it with him in fact most of the time, is therefore hardly the riddle that it is popularly held to be. Still, the very admission that despite his losses he returns again and again, carries with it the suggestion of an addiction, a compelling force, a deranged mechanism; so that, recalling the physiology of the emotions, as we now understand it, one is inevitably moved by a desire to win to a conception, however provisional, of the morbid physiology implied by the habit of the gamester.

While in the present state of knowledge attempts in this direction can scarcely be expected to rise much above the level of tentative approximations; still, something, the writer is fain to believe, may be done to satisfy the desire to rationalize, and this without any very glaring violation of the canons of common sense. A glance at the opinions now prevailing regarding the physiology of the emotions will help in an attempt of this kind. Two principal theories, each having advocates more or less, should be considered. According to the first and older conception, the mind (brain) "feels" in a definite way immediately upon excitation, whether from without or within. Only subsequently does this "feeling" (emotion) manifest its presence by purely nervous phenomena (discharges). On the other hand, it is maintained, notably by James and Lange, that the body itself reacts primarily in a definite way to a given stimulus; that the mind becomes aware of this bodily perturbation ("feels it"), and that this feeling, whether of tension or relaxation, is the emotion. For, as James observes, "If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its bodily symptoms, we find we have nothing left behind, no 'mind stuff,' out of which the emotions can be constituted, and that a cold and neutral state of intellectual perception is all that remains."[6]

If it be granted that the position of James and Lange is well taken, and in the writer's opinion it is open to fewer objections than any other, we may conceive the genesis of an emotion to be somewhat as follows: A sensation, auditory, visual or what not, or a perception, or an idea, gives rise in the brain (cortex) to an impulse which is disseminated centrifugally to the motor apparatus. Muscular contraction ensues, and it is the sensations due to contraction of the muscles, transmitted to the sensorium by the centripetal system of nerves, to which vasomotor, visceral, and other sensations are added, that give rise to the emotion.[7]

Now, as already sufficiently accentuated, the emotions in gaming are aroused or rather racked in a unique and extreme fashion. That in time the affective functions, motor, vasomotor and sensory, must inevitably become erratic, disharmonized, seems a wholly warranted conclusion. Here, then, are all the psychoneural elements necessary to the establishment of addiction; and it is a matter of surprise to the writer that an implication so apparent should have been so widely overlooked.

From the foregoing considerations, it is easy to understand why those who are the chronic victims of the gaming habit are so little fitted for the routine that enters so largely into the activities of common life. This inefficiency of the gamester has long been recognized; and his restless, feverish nights, with their succeeding days of futile, maundering wistfulness, have provided texts for the diatribes of the moralists. Not much, in view of history and the practically universal love of hazard, can be accomplished by such fulminations. Nor has drastic legislation, however much it may have helped to mitigate it, sufficed to suppress the gaming evil. Of more promise, perhaps because more rational, would be a systematic attempt to spread abroad a knowledge of the essentially morbid nature of the gaming habit; while at the same time frankly recognizing the legitimacy of the love of hazard when properly applied, as in the building up of new industries, war, games of skill and the like. A considerable approval of the drama of the better sort should likewise be expressed, since through its mechanism both a logical progress and a logical ending are made possible, while at the same time suspense is maintained without undue racking of the emotions.

While this is doubtless true enough, it is nevertheless not to be forgotten that however much the intellect and the imagination are concerned in the making of a play, its enjoyment by the spectator is relatively a passive one. Quite the opposite is true of the experimental sciences, the pursuit of which makes a constant demand upon the active resources of the mind. Here, too, as already intimated, there is suspense, but without those sharp alternations so characteristic of gaming. There is, moreover, the further merit of a possible enlightening or useful outcome, the consciousness of which cannot fail to bring its own meed of satisfaction. Unfortunately though, the present age has been aptly characterized as "the scientific age," science and invention are not for all; nor in view of the average make-up of human intelligence, are they ever likely to be so.

From the foregoing analysis, it may be fairly assumed that—

1. In its more extreme manifestation, the gambling habit may disclose many of the attributes of a true psychosis.

2. This is especially true of the habit as observed in neurotic individuals, or those in whom the psychotic impetus is enhanced by paranoid or hysterical coincidences.

3. While many persons are led by a desire for diversion to indulge from time to time in games of hazard, there is always more or less danger, especially in the case of idle, excitable, unbalanced persons, of the gradual establishment of addiction.

4. It is the rapid alternation of opposing emotions that provides the chief suspense and major excitement of gaming. Herein is likewise to be found the source of its allurement. A contributory, though subordinate, enhancement of suspense is discernible in the stake.

5. The suspense curve in the drama is less sharp by far than in gaming. In other words, there are fewer alternations, and consequently there is less racking of the emotions in a given length of time in the former than in the latter.

6. Of original work in the experimental sciences, it may be confidently stated that while suspense is an ingredient far from insignificant, it is brought about not by rapid affective oscillations, not by an emotional riot of to-and-fro as in gaming, but by far more gentle undulations than even those met with in the drama.

7. Since the suspense in games of pure hazard is brought about in an arbitrary manner, without any noteworthy participation of the intellect; and since, moreover, habitual gaming tends to engender distaste and even to unfit its votaries for concentrated mental effort, the practice is to be condemned on psychopathological grounds, if for no other reason.

8. While the love of hazard appears as an indigenous and even useful quality in the history of the race, nothing is more certain than that from time immemorial it has been shunted, as in gaming, from its true sociological intent.

9. The gaming habit in its more exaggerated forms, especially when complicated by neuropathic adjuncts, is rather an affair of psychopathology than of morals.

10. Dissemination of knowledge regarding the essentially morbid nature of the gaming habit, coupled with a dispassionate and explicit account of its inroads on mental efficiency, should help, it would seem, to a rational prophylaxis.

Much has been said and written about the facial expression of the gamester, and not a little of this commentary has crept into fiction. Thus we hear of the "gambler's face," implying thereby a certain "hardness" of visage; a hardness which, however apparent, can nevertheless scarcely be regarded as an exclusive adjunct of those who habitually indulge in games of hazard. Still, it cannot be denied—and this is an interesting and revealing circumstance—it cannot be gainsaid that there is usually a vast difference in facial expression between those in whom suspense is brought about by the drama or the pursuit of the experimental sciences, and those in whom it is produced by gaming. And more striking, it may be observed parenthetically, than even this disparity, is the contrast in the expression of the face between those who gamble and those whose efforts are directed to literature and the arts.[8]

Facts of this kind are their own commentary.

[6] "The Principles of Psychology," by William James, Vol. II, p. 451. 1907.

[7] For an explicit account of the anatomical mechanism which is held in some quarters to subserve a purely emotional and expressional purpose, the writer ventures to refer to his paper, "The Diagnostic Significance of Abnormally Quick Fatigue (Apocamnosis) of the Orbicularis Oris Muscle," published in the *Medical Record*, August 17th, 1912.

[8] A rather full list of the more important literature dealing with expression of the emotions will be found in the Introduction of Charles Darwin's "Expression of the Emotions in Men and Animals." London, 1872.

Suez Canal Is Not Owned by the British Government

THERE has been so much loose and uninformed talk about the ownership of the Suez Canal in connection with the discussion of the Panama Canal bill that a statement of that ownership seems timely. It is alleged, for instance, that Great Britain owns it, through her occupation of Egypt, or directs it by ownership of a majority of the shares, or allows her own vessels to use it without paying tolls, while collecting those of other countries.

The Suez Canal is an Egyptian company, authorized by a decree of the Khedive, March 19th, 1866; it is governed from Paris. The British government does not own it, but is merely a private stockholder, and does not own even a majority of the shares. It has, in fact, an equity which might, in conceivable circumstances, be extinguished altogether. On the board of directors there are twenty-one French members, one Egyptian member, and ten English members who constitute what is called the "London Committee." The manager and secretary, together with the president, and even the manager of the London office, are all French.

The capital of the company, authorized and issued, is 200,000,000 francs, in 400,000 shares, of which 378,231 shares of 500 francs each, fully paid, were in issue on December 15th, 1911, 21,769 having been redeemed. These shares are redeemable at par within 99 years from 1869 by annual drawings on December 15th. They are, in one sense, a mortgage, because they are entitled to 5 per cent interest and dividends up to 71 per cent of the surplus profits. The redeemed shares are replaced by certificates which relinquish the 5 per cent interest.

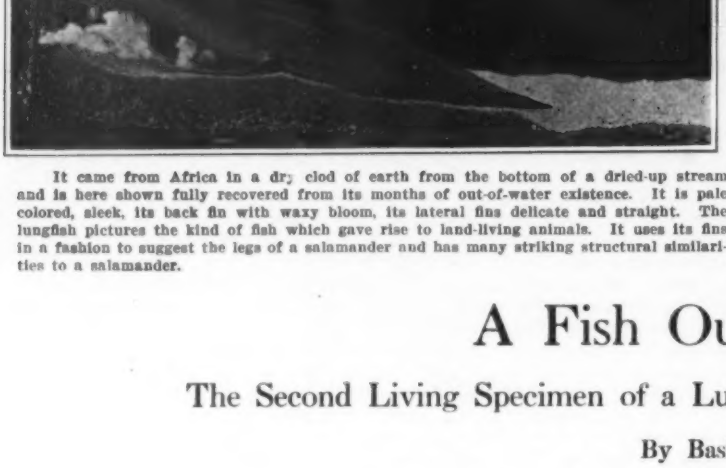
In 1875 the British government, at the instance of Mr. Disraeli, purchased the holdings of the Khedive of Egypt, who was in urgent need of money at the time, and was practically an independent ruler, in spite of the nominal suzerainty of the Sultan of Turkey. There are 176,202 of these shares, and these may be all redeemed between now and 1968 by annual drawings, although they will retain their right to the dividends but not to the 5 per cent interest. This amount does not constitute a majority of the capitalization, to say nothing of the 400,000 shares of capital stock.

Underlying obligations take the form of bonds or shares. Of the latter there are 372,531 of 85 francs each, redeemable up to November, 1922; 99,994 of 5 per cent bonds of 500 francs each, redeemable on or before July 1st, 1918, by annual drawings; 62,944 first series 3's now outstanding, redeemable annually up to 1935; 232,592 second series 3's, redeemable by annual drawings up to August, 1963; while an authorized issue of 150,000,000 francs of the third series of 3's is now in course of issue and is redeemable at par in fifty-three years, the company reserving the right of expediting the redemption. It is understood to have this right in all the issues with the exception of the original shares.

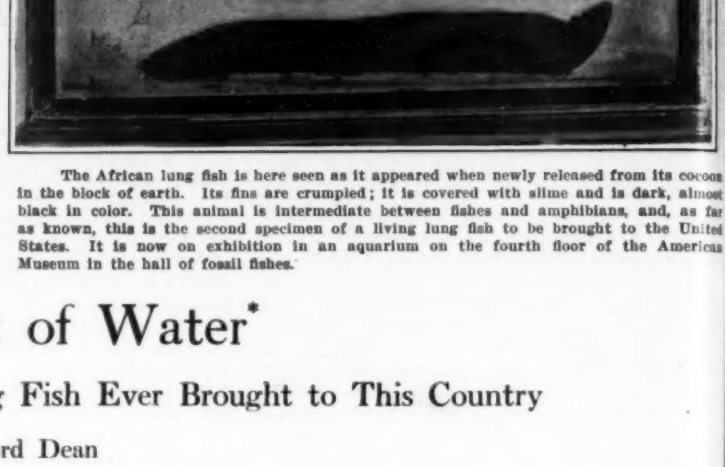
So far as any rebate of the tolls is concerned, neither the British government nor the French government, which incidentally, is not a stockholder although a majority of the shares is owned in France, rebate the tolls, or have the right to do so. No doubt, like other maritime nations, they subsidize for mail purposes, and possibly for use in war, vessels which use the canal. But these subsidies are not paid from Great Britain's dividends on its Suez Canal shares, and are extended to other vessels which do not use the canal at all.—*The Wall Street Journal.*

Air Compression

THE efficiency of compressed air can be greatly increased by reheating. The gains are both direct and indirect. The chief direct gain is in the greatly increased efficiency of fuel used in the heating stoves as compared with the effect when coal is burned under boilers. It is commonly stated, and the statement is fairly correct, that when 1 pound of coal is burned in a reheater stove the commercial effect is as great as 3 pounds when burned under a boiler. The increase in commercial efficiency when reheating air from 60 deg. Fahr. to 400 deg. Fahr. may be put at 35 per cent. The indirect gains are better lubrication of the compressed-air engine; less investment required, as a smaller plant will be needed; reduction of compressor engine friction as compared with the useful work done. —*Mines and Minerals.*



It came from Africa in a dry clod of earth from the bottom of a dried-up stream and is here shown fully recovered from its months of out-of-water existence. It is pale colored, sleek, its back fin with waxy bloom, its lateral fins delicate and straight. The lungfish pictures the kind of fish which gave rise to land-living animals. It uses its fins in a fashion to suggest the legs of a salamander and has many striking structural similarities to a salamander.



The African lung fish is here seen as it appeared when newly released from its cocoon in the block of earth. Its fins are crumpled; it is covered with slime and is dark, almost black in color. This animal is intermediate between fishes and amphibians, and, as far as known, this is the second specimen of a living lung fish to be brought to the United States. It is now on exhibition in an aquarium on the fourth floor of the American Museum in the hall of fossil fishes.

A Fish Out of Water*

The Second Living Specimen of a Lung Fish Ever Brought to This Country

By Bashford Dean

FAITH in our conception of what a fish ought to be is certainly shattered when we find one which can live for months, possibly for a year, out of water—which breathes by means of gills when in water, but with a lung during the summer drought, inhaling and exhaling air as though it were a land-living animal. Such a queer fish was recently sent by Dr. Joseph A. Clubb to the American Museum of Natural History in an exchange with the Public Museums of Liverpool. It came from the Gambian region of Africa, coiled up in a kind of cocoon, deeply sunken in a large clod of earth which months before had been a bit of the bottom of a dried-up stream. When received at the American Museum the cake of earth showed, as a sole sign that anything alive was within it, a little tunnel-like opening where the fish burrowed when the earth was still soft, and through which the fish later secured its supply of air for breathing.

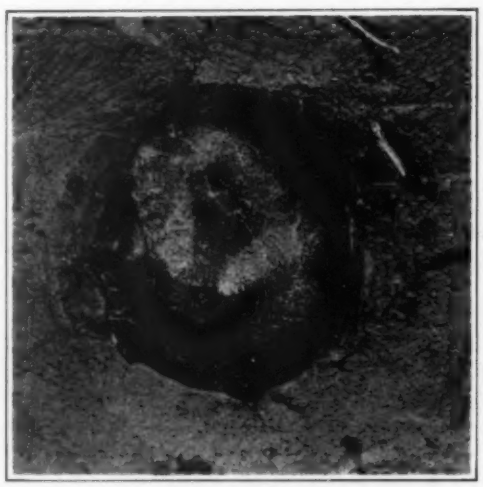
Indeed it is this opening which gives us the clue as to how the dormant fish can best be examined. For we may begin at the edge of the tunnel and chisel the hard earth away, and on reaching the bottom we may, cutting with greater care, expose the side of the capsule within which the fish is tightly coiled. The whole mass is then placed in tepid water to soften the wall of the capsule (which was formed by mucous secretion on the surface of the fish's body) and thus to allow the fish to escape. Within a few minutes after the present cocoon had been placed in water, the papery wall or shell showed movements, but before the fish broke its way out, a trap door was cut in the side of the capsule so that a photograph could be taken. The mass was then again placed in water and within a few minutes the fish emerged.

This lungfish is now exhibited in an aquarium on the fourth floor of the Museum in the hall of fossil fishes. It has been placed there since it is at home, scientifically speaking, among fishes which lived millions of years ago and whose race is almost extinct. It furnishes, in fact, an excellent instance of the survival of a race of animals from a very ancient period of time. It has further clai to our interest, for we can safely say that a lungfi pictures the kind of fish which gave rise to the earli land-living animals, or the stock of amphibians, reptil birds and mamals. In fact the present little fish is kno by anatomists to have many striking similarities to sa manders. Thus in a general way, its limbs represent stage between fins and hands, and it uses them in a fa ion which suggests a salamander. So also in struct of skin, muscles, skeleton and brain, the fish is to a c tain degree, a connecting link between the true fis and the four-footed animals.

As far as known, this is the second specimen of a livi lungfish to be brought to the United States, and th who are interested in natural history in general and fishes in particular, would perhaps be glad to profit the opportunity of seeing it alive. Its scientific na *Protopterus annectens*, by the way, refers in the first w to its supposedly primitive fins, and in the second t being intermediate between fishes and amphibians.

* Reproduced from the *American Museum Journal*.

A block of dry earth (greatly reduced in size) in which is encased a living lungfish. The funnel-like opening for air shows at the upper right hand. This block of earth came from Africa in a box provided with holes to admit air for the fish's breathing.



Here earth has been chiseled away to the cocoon containing the fish. At one point this cocoon shows the pit through which the fish breathes. The pit leads to a tube of hardened slime which goes into the fish's mouth, and conducts the air directly to the lung.

The cocoon of the lung fish seen from the side when ne separated from the inclosing mass of earth. It i papery texture and is formed of hardened layers of s secreted by the fish around his body at the onse a dry season.

Greenland's Eden

An Oasis in a Desert of Ice

By Robert G. Skerrett

A DANISH expedition is likely to help us to understand better the part Greenland's ice-cap plays in breeding icebergs to menace our over-sea traffic upon the North Atlantic. The public generally does not know it, but interior Greenland is only imperfectly known. The little map accompanying this article shows the routes of earlier explorers and also the lines of march of the two latest expeditions. Of these, the far more important is that headed by Capt. J. P. Koch of the General Staff of the Danish Army—a man who has already spent some years in following unbeaten tracks in Greenland.

In 1906 to 1908, Mylius Erichsen headed the so-called Denmark Expedition, and his work was invaluable not only in definitely settling the contours of part of Greenland's remote northeast coast but likewise in disclosing a remarkable geographical anomaly in the very midst of the inland ice. It was then that Queen Luise Land, an area of about three thousand square miles, was discovered rising clear and free of the great surrounding ice waste. Capt. Koch was a member of that exploring party, but he and his fellows were obliged to abandon the investigation of Queen Luise Land other than to take a mere superficial view of its easternmost rim. The present undertaking, in which Capt. Koch is joined by two other scientists—Dr. Wegener of the German Universit Marburg and Dr. A. A. Lundager, a botanist—and Icelander of the name of Sigurdson, who will have ch of the transport facilities, is for the very purpos exploring intimately this comparative Eden is amid a vast expanse of ice and snow.

According to Capt. Koch, Queen Luise Land pro to be singularly rich in animal and vegetable life though surrounded by conditions which would narily have doomed it to absolute barrenness. A expressed it: "We stood face to face with a geolo puzzle—the mysterious glacial age. We had befor

The moraine of the border of Greenland's inland ice. The great masses of broken stone are being shoved slowly along by the irresistible advance of the glacier.

an exact duplicate of the Scandinavian mountains as they probably looked in those far-distant days when their highest peaks began to rise clear of the ice which had so long buried them. We saw with wonderment that the summer was born and the rivers ran freely a month earlier in this region of ice than nearer the coast, but we were quite unable to understand why this was so. We had seen the eastern and the northern rims of this climatic wonder, but we knew nothing about how far west the high mountains extended. The remarkable pictures of ice forms which we carried away with us served only to increase our amazement, but we had no chance to study the mechanics, as it were, of the glacier. Our photographs added new links in the chain of fact upon which the theory of that ice formation hangs. We had to turn our backs upon this strange contradiction of Nature, and we did so with deep regret. Nevertheless, we cherished the hope of some day returning to complete the explorations and the study of this fascinating Queen Luise Land." Capt. Koch is now upon the eve of realizing that hope.

For the present expedition, the Government has furnished a sturdy three-masted schooner, the "Godthaad," which has been doing service between the mother country and Greenland for the past few years. The rich Danish brewer Jacobsen and other prominent Danes have conjointly subscribed a fund of $25,000 for the undertaking. The explorers are journeying from Iceland to Denmark Harbor, whence they will strike inland to their objective about a hundred and twenty miles from the coast, where they will winter in order to study some of the conditions of that territory during that season. Heretofore, the Eskimo dog had been deemed an indispensible beast of burden and transport in the frigid northland, but Capt. Koch has instituted an innovation: he will employ for this work fifteen Iceland ponies instead. These vigorous little animals are surefooted and of great endurance, and, besides, are willing and contented with little. For food they will have hay for a while, but they will subsist later upon compressed cakes composed of oatmeal and syrup. The particular reason for utilizing these ponies is that the overland exploring of Queen Luise Land and its mountainous character would be too much of a tax upon dogs which are at their best when traversing snow and ice. Another novelty will be motor boats which will be used during the earlier stages of the work in getting from Denmark Harbor inland by way of the open water and deep streams and lakes which abound in the summer season near the coast. The total weight of provisions, clothing, sleds, etc., is about 40,000 pounds, and the main part of this will be carried no farther than the winter quarters which have been already prepared in part on the eastern outskirts of Queen Luise Land by the military force now stationed at the nearby arsenal at Denmark Harbor. The explorers will use wooden shoes filled with hay, and these are expected to endure the rough work ahead and also to safeguard the men's feet from frostbite. This has been one of the vexatious problems with past expeditions.

After wintering on the eastern edge of Queen Luise Land, Capt. Koch and his fellow explorers purpose devoting the months of March and April to investigating that strange territory. When he and his earlier companions discovered that land they found the hare, the fox and the musk-ox abundant. By the first of May of next year, the party will resume their journey across Northern Greenland; and if all goes well they should reach Upernivik on the west coast sometime in July. They will have to abandon most of their ponies, but four of them will be utilized, with four sleds, for the trip over the inland ice westward. However, provisions will be carried for three months, which would be the time required for the journey on foot should the ponies fail.

Capt. Koch has given in a very recent account of his previous travels in Greenland a picturesque idea of that country's northeastern coast in the summer time. In a measure this gives a fair idea of the atmospheric and soil conditions of Queen Luise Land, but otherwise the circumstances are unlike that of the coast.

"It is quite cold at night. In the daytime it is so warm that the mosquitoes are a great bother; bees and other insects are seen. The blueberries are in fruit. Heather, poppies, and a rare luxuriance of beautiful Arctic flowers are in blossom. Sparrows are here with their little ones; and we have found a variety of bird's eggs. The seals are sunning themselves upon the ice, but they are shy and hard to reach, which makes hunting them more exciting. The fox and the hare scurry past wherever one goes. Running brooks are scarcer now, but there are plenty of pools and ponds on every side pouring toward the sea. Delicious salmon are abundant in the fresh waters, and it is now time for fishing. The seals gather in big herds to catch them, and it is, indeed, a day of abundance for them."

Outline sketch of Greenland, showing the routes of the past and the present exploring expeditions. These indicate how little is known of the interior of Greenland.

Queen Luise Land rises to a height of quite 6,500 feet above the level of the sea right out of the great surrounding ice-cap, and the highest point of this land reaches above the ice something like 3,500 feet. This means that the encompassing glacial waste is anywhere from 1,000 to 3,000 feet thick from top to bottom where it rests upon the underlying land. As a matter of fact, most of the ice in the form of bergs which reaches the North Atlantic comes from the western coast of Greenland, the general movement of the tremendous ice-cap or glacier being from east to west, the icebergs forming as this immense body pushes shoreward through the valleys and defiles and launches its grim offsprings upon the Arctic waters lying between Greenland and the coast of Labrador. One of the principal studies which Capt. Koch and his companions will pursue is that of determining something about the rate with which the ice-cap moves coastward. Watching the ice formation at the edges of Queen Luise Land and studying the geological records of its recession, it will be possible to tell more of Greenland's past history and the meaning of Queen Luise Land's very existence as it appears to-day. Capt. Koch and his associate scientists may possibly discover the secret of Greenland's ultimate freedom from this icy burden, and this, in turn, will tell us more of the glacial era, from which we emerged ages ago. Capt. Koch is but forty-two years of age and a typical Scandinavian. Those that know him intimately describe him as a man of fearless energy, but with that energy under perfect control. His present undertaking is the culmination of his past labors in the Northland and some years of deliberate planning. Apart from exploring Queen Luise Land and ferreting out some of its geological secrets, he is laying the groundwork for a systematic survey of the entire coastline of Greenland. The task he has set himself is an ambitious one, but work that is really necessary to fill many of the gaps in the existing maps of that imperfectly-known territory. The Danes believe that Greenland is rich in mineral wealth.

The interior of one of the glacial ice caves taken by flashlight. The broken stone in the foreground is advancing with the characteristic slowness of the glacial movement.

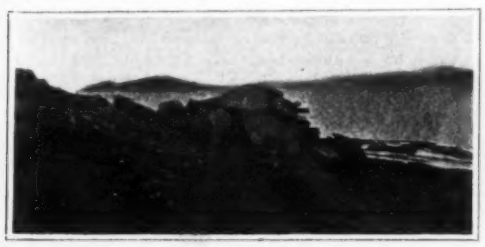
The stone remnants of a fox trap built by Eskimos who disappeared from the northeast coast of Greenland centuries ago.

The entrance to one of the marvelous ice caves which Capt. Koch discovered during his last exploration.

Uranium and Its Uses

THERE is considerable popular interest in uranium in the United States on account of its connection with radium, the properties of which appear so marvellous when compared with those of more familiar materials. Very little uranium is mined in the United States, except as it is incidentally taken out in mining carnotite for vanadium. In 1911 the uranium mined amounted to about 21.2 tons. A few hundred pounds of pitchblende was taken from the German mine, at Central City, Colorado.

The extraction of radium has been attempted in the United States by several persons; some of them have given up their efforts, but others are still at work, with what success is unknown. The uses of uranium and its compounds are comparatively few. It is employed principally for making yellow glass, for making yellow glazes for pottery, and in a less degree as a chemical reagent. Yellow glass made with uranium is known as "opalescent." Some of the firms who have attempted to use uranium in the manufacture of steel have abandoned such experiments, the claim being made that it imparts almost the same properties as tungsten and is very much more expensive.—*The Chemical World.*



The grave of an Eskimo of the distant past discovered by Capt. Koch upon the northeastern coast of Greenland.

Recent Development of the Locomotive—IV*

The Latest Stages in Its Evolution

By George R. Henderson

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 1933, page 36, January 18, 1913

ELECTRIC PROPULSION.

IN the last ten years the wonderful advancement made by electricity in all lines of work has led some to believe that the days of the steam locomotive are actually numbered and that it would soon become a thing of the past. This belief has been expressed by some men of high standing in political affairs, if not in mechanical, and the great successes attending the application of electricity to street-car lines, suburban transportation, elevated and subway roads have rather brought about a popular opinion harmonizing with the above-mentioned assertion.

The operation of a street-car system, suburban system, elevated or subway railroad is so entirely different from the operation of the average steam railway that there is really little actual comparison between the two. Estimates have been made upon the cost of operation of a steam line, based upon the results found when the elevated railway lines in New York city were electrified, by comparing the new results with those of the old steam operation, and it was only a few years ago that some electrical engineers of considerable reputation advanced the theory that if all the steam railways in the country were to be electrified a saving in the cost of operation would be made which, while not quite equal to that claimed by Mr. Brandeis, to be effected by adopting economies, yet would be well worth considering as means for economical operation.

No one can deny for a moment the great advantage to city and suburban life of the trolley car, and it is this, probably more than anything else, that has given our cities an outlet for their increasing population and made suburban life a happiness instead of a drudgery; but even this has not been altogether without financial disappointment to the electric railway companies, as only a few years ago many of them were being sold under foreclosure and only really made money when operating upon a new basis of cost, which had the result of very materially scaling down their fixed charges.

When we consider the application of electricity to the New York Central Terminal tracks in the city of New York, it is often asserted that this substantiates the theory of the devotees of electric propulsion, and this has been made great capital of by electrical engineers in order to enforce their pet schemes, which have been, no doubt, largely developed by over-enthusiasm in their particular line of work. As a matter of fact, the profit of operating the New York Central Terminal line by electricity over the steam line is not large, and the capital expenditures have been something enormous. It was stated several years ago by the vice-president in charge of electrification that the consequential costs were about four times the actual costs of electrification, by which he meant the arrangement of depots, tracks, terminals, round-houses, and other facilities which would necessarily enter into the electrification. The fact that there is a margin of profit was shown very clearly in a paper presented to the American Society of Civil Engineers by the official mentioned above, an analysis of which showed that if the actual amount of traffic or the load factor had been less regular there would have been an increased expense instead of an economy. To make this somewhat clearer, we would state that if the power requirements had been so irregular that the facilities of the power-house would need to be doubled to carry the movement over the maximum peaks there would actually have been an extra expense, but, on account of the uniformity of movement, the power-house equipment could be so adjusted that the interest on investment was not so great as to overcome the economy effected in the actual movement of the trains.

On the other hand, it has been but a few months since the New York, New Haven and Hartford Railroad claimed an increased cost of operation, due to electrification, when this subject was considered for the application of similar conditions to the Boston territory, and, at the best, it would seldom, if ever, be claimed that the economy resulting from electric operation will ordinarily be so great as to make it an attractive financial proposition for the substitution of electricity for steam. There are other conditions, of course, besides the financial part of the problem, such as existed in the tunnel under Park Avenue in New York city, where steam operation was almost intolerable to patrons of the road, not only from the liability to accidents, but from the partial suffocation which everyone experienced in going through the tunnel in hot weather. The question of relieving the city of the smoke of the locomotives was also an important consideration, and it was these features and *not* the prospect of financial improvement that forced the electrification upon these roads, and we believe that we may well say "forced," as they certainly would never have gone into this project had they not been driven into it by the residents of New York city and the commuters who daily passed through the inferno of the Park Avenue Tunnel.

The consequential damages referred to above can sometimes be reduced or made into an actual asset by utilizing the space which would not be available under conditions of steam operation. This is illustrated by the New York Central construction which is now being completed in New York city. The large amount of open space required for the escaping of the gases and steam from the locomotive smokestack can, in the case of electric operation, be reduced to a very small quantity, and the overhead space so vacated by steam and smoke can be utilized for office buildings and other purposes. Of course, this depends largely upon the locality, and there are comparatively few places in the world where this would be as remunerative as in New York city. It is a phase of electrification, however, that should be given due weight when considering the financial returns on any scheme of this kind.

On the other hand, we must consider what actually happens in the way of transportation density and uniformity on many of the railroads in this country, and perhaps we should say on nearly all of them, outside of a few in the most populous districts. It has been claimed that the one requirement for successful financial electric operation was density of traffic, but we believe that uniformity is just as important as density. For instance, let us compare a road like the New York, New Haven and Hartford Railroad or the Pennsylvania's Atlantic City line. Here the passenger travel is great at all times of the year, and is quite uniform during the day and night, so that frequent train service is required at nearly all hours. In this case we have not only density but uniformity, and as stated above, it is this item that gives us the saving in the electrical operation to the New York Central's Terminal System. The same is true of the New York Elevated, which runs trains very frequently at all hours of the day and night, maintaining a high load factor, and, while there are peaks, to be sure, yet these peaks are not so far above the average movements as to require an excessive expenditure for installation in the power-house.

From this let us go to the other extreme and consider a line in the West where there is very little local traffic, except that on one or two nights in a week a heavy stock business exists to bring cattle to the following day's market. This business is onerous and exacts and requires high speed and delivery at the expected time without fail; otherwise consequential damages may be assessed against the carrying road. It is not uncommon for this division, which may see two or three trains a day ordinarily, to have twelve or fifteen heavy stock trains pass through it in the course of a few hours at some one or more times during the week. These trains are usually sent in fleets in order to insure better dispatching and also to enable them to arrive in suitable time for the next day's market. The amount of power required on this division at this particular time would be extremely high. If we consider such trains (and they are run at high speeds requiring about 2,000 horse-power for their operation) and suppose that fifteen are handled, we see at once that each division power-house must be sufficient to give at least 30,000 horse-power output. The rest of the week the output would probably not be over 3,000 or 4,000 horse-power at any one time so that a large amount of machinery must be installed in the power-house to carry this exceptional peak load and this machinery is non-remunerative for the other six days a week and represents idle investment. This must be repeated at every division power-house which is used to provide power for such a movement and shows at once the futility of arguing that electrification would be applicable to all roads. The steam locomotives can be bunched, grouped and transferred from one division to another and make a particularly elastic medium of power transmission as the next day the locomotives can simply be placed upon another division where their services will be needed; moreover, the cost of a horse-power represented by steam locomotives is approximately $15 each, whereas a modern power-house with the transmission lines will cost fully $100 per horse-power, to say nothing of the fact that electric locomotives are nearly double the price of steam locomotives.

These conditions are brought to your attention, not with the idea of belittling by any means the use of electricity for transportation purposes, or of trying to prevent extensions in that line, but are simply presented so that these matters may be so clearly understood that the enthusiasm of some electrical experts may not be permitted to get the best of sound judgment, which, if allowed to occur, will eventually react and injure the cause more than it will help. On the other hand, we would not be surprised at any time to learn that the Pennsylvania Railroad, for instance, would electrify its entire system between New York and Washington. The present New York Terminal is operated entirely by electric locomotives; the subject is being now studied in regard to Philadelphia; the tunnels at Baltimore will certainly soon require heroic treatment; and, in order to prevent the objectionable smoke in the capital of our country, electric traction would be considered a great advantage. These four links in a line 250 miles long, and the density and uniformity of traffic which passes over these divisions, make this quite an attractive subject for electrification, but there can be no comparison between this piece of track and that above described, which represents a condition found in most of our Western States. There is no question but that electric traction will increase, but we believe that steam traction will increase still more rapidly, and that the steam locomotive will not be relegated to the museum or the scrap pile during the life of any one present at this meeting.

There are three different ways in which electric locomotives can be operated: first, by collecting the current as the locomotive moves from either a trolley wire or a third rail; second, by means of storage batteries carried on the engine or tender; third, by means of internal combustion or other motors generating electricity as required which actuate motors geared to the axles. The first method has certain advantages not enjoyed by the others, and is the one generally employed for handling heavy trains through long distances. The great advantage which results from this arrangement is that the full output of the power-house is available at the motors and the capability of doing work is limited only by the characteristics of the motors installed upon the engine. It is possible with such a combination to obtain much greater tractive forces with high speeds than can ever be hoped for with a steam locomotive, because the latter is dependent upon the capacity of its boiler and fireman, whereas the electric locomotive can receive its power from a plant which will deliver many more horse-power than could possibly be obtained from a locomotive boiler. It is this phase of the question which has been urged so largely in the endeavor to place electric locomotives on heavy grades and mountainous sections, but, outside of some special pieces of track where tunnels make the operation of steam locomotives objectionable, there has been little done in this country along this line, and, although such plans have been investigated, they have not ordinarily been found to be financially attractive. There is no question but what there are great possibilities in this line, provided that the costs are not out of proportion to the benefits developed. The motors, of course, have certain limits, principally governed by their ease of disseminating heat, and it is the heat limit that prevents more power being put through any given motor. There have been cases in the West where even water-power, with its generally attractive features, has not been considered as a satisfactory financial proposition; where the cost not only of producing but of transmitting the electric current from the water-power to the railroad was found to be too great a financial burden to expect an equivalent return.

For comparatively short lines with dense and uniform traffic, however, there is probably no other method which is likely to be considered, the choice lying between the third rail and the overhead trolley suspension. Both systems have their advantages and disadvantages, but either can be operated satisfactorily, as demonstrated by the locomotives used on the New Haven road, which, while on the direct current territory of the New York Central, collect from a third rail, and when on the alternating current sections of the New Haven collect from an overhead wire. The motors in this case are single-phase and can be used either on direct or alternating installations. In the latter case the current is transmitted and used at a high voltage, namely, 11,000, while in the direct current the ordinary voltage is 660. It is this difference in voltage that makes it feasible to use third rails with low voltage, which would be considered unwise with the voltages used on the New Haven over-

*Paper read before the Franklin Institute and published in its Journal.

head line. Even at certain points the low voltage direct current must have overhead connections, as at complicated switches and crossings where a continuous third rail is not practicable, but that both systems can be operated satisfactorily is amply demonstrated not only by the trolley car service with its suburban connections, but by the several steam lines which have divisions operated electrically.

There are certain places, however, where it seems impracticable to use satisfactorily either the overhead trolley or the third rail, and these are in freight and classification yards where much shifting is necessary and a great number of switches are encountered. The necessity for men moving on foot over such a yard to do their work in connection with the makeup of trains renders the third rail a very serious obstacle, and the presence on top of box cars of brakemen giving signals, etc., renders an overhead wire dangerous and unattractive. For such a condition, either a steam locomotive burning anthracite fuel or with some smoke-consuming device that is effective can be used, or a locomotive operated with a storage battery, which is, perhaps, the most attractive proposition. These batteries can be carried in a separate car or tender and can be recharged and simply picked up by the locomotive, discarding its discharged battery car when necessary. Of course, the expense of such a locomotive is high, and it is possible that some special batteries like the new Edison quick-discharge and recharge battery would alone be acceptable, but the expense, of course, would not be as great as the installation of third rails and overhead wires, and the locomotive has the advantage that it can move on ordinary track, pass into and out of private yards and buildings without any restrictions, and can simply replenish its current when necessary as a steam locomotive would take on coal and water. On account of the great cost of these locomotives, however, which is principally involved in the storage battery, it is not likely that such a system would be developed to any great length of line, but for terminal work and switching around a number of spurs and individual properties it seems like a very attractive proposition.

The internal combustion motor generating its own current has been made use of in a number of isolated cases, and for branch service and where the service is light and the trains few it answers the purpose admirably. This, however, is also quite an expensive machine, as we must have the power generated converted into electricity and back again by the motors into power, which makes an elaborate system of machinery, and, while it answers the purpose well for branch service, it would not be satisfactory for hauling heavy trains in main line work. The cost of operation of such motors is comparatively low, but the principal saving is in reducing the number of men in the crew. A single car can be operated with two men, whereas the least number that could be run with a steam locomotive and passenger cars would be four men. The uncertain cost of gasolene is also a factor in this method of operation, which is not entirely satisfactory, and when it comes to taking care of such a machine it is certain the car shed will not be a suitable place for doing this work, nor will the round-house be appropriate for the passenger portion of the vehicle. We therefore believe it safe to say that for heavy main line work either the third-rail or the trolley system will be found most acceptable, and that the second and third systems above described will be found useful adjuncts for certain parts of a railroad system, but that they cannot be seriously considered for heavy through traffic.

The type of electric locomotive which collects current as it moves, whether by trolley or by third rail, has individual characteristics considerably different from the steam locomotive. Several general arrangements are in use which might be divided ordinarily into three different types: first, that in which the motors are mounted directly on the driving axles of the locomotive, although this does not mean rigid connection, as they are generally arranged to turn the driving wheels through a flexible connection; second, that in which the motors drive the axles through the medium of spur gearing; and, third, that in which the wheels are driven through connecting rods. In the early days of the development of electric locomotives the first arrangement was considered the most desirable, as the center of gravity was brought quite low and there was an absence of connecting and transmitting machinery. For many years the increasing height of center of gravity of locomotives has been a bugbear to railroad men, and when the very low center of gravity produced by the first arrangement of locomotive was proposed, it was considered that this would be practically ideal. One or two disastrous wrecks, however, led to a more careful study of this question, and one railroad made an elaborate series of tests with different types of steam and electric locomotives, both on straight line and curved, to determine what arrangement of wheels, etc., gave the least strains upon the track.

While the high center of gravity is more dangerous by overturning the locomotive at excessive rates of speed, yet there is no question but that the low center of gravity puts more stress upon the outer rail of the curve and its tie connections. It can readily be shown that while the centrifugal force is the same for locomotives either with high or low gravity with the weight, speed, and radius of curvature the same, yet the high center of gravity throws an increased weight upon the outer rail, thus forcing it more tightly to the ties and reducing the shearing effect of the horizontal centrifugal force. The later electric locomotives which have been built for the Pennsylvania railroad are operated by a single motor connected to the wheels by means of an inclined connecting rod. This gives the advantage of concentrating the power into one motor, which is generally more efficient, and also raising the center of gravity more to the conditions of a steam locomotive. The geared locomotive raises the center of gravity to a position between the connecting rod and the engine in the gearless type, but does not concentrate the effort into a single motor.

A technical discussion of the details and characteristics of these different types would be out of place in such an article, and all of them are giving very satisfactory results in service, but the principal points of interest have been referred to so that in a general way some idea could be had of the line of thought leading to these three varieties.

As to the question between direct and alternating current, each has its advocates and each has some advantages not possessed by the other. Alternating current motors, when of the single-phase type, can be so constructed that they will operate on either direct or alternating current, although a motor that is built for operation on only one, will be more efficient and lighter than a locomotive built to operate on both circuits. One of the principal reasons for increase in weight in the combination locomotive is due to the fact that it must be provided with both resistance grids for the D. C. current and auto-transformers for the alternating current. With the direct current, the speed regulation is arranged by using the series or parallel operation in connection with reducing the voltage by passing it through resistance coils or grids. This is wasteful and is only intended to be used in starting and under certain conditions of slow speed. The alternating current varies the voltage by means of taps taken off from different parts of the transformer coil, and is free from the wasteful resistance of the direct current means of regulation. Both types can be coupled up to provide multiple unit control, so that one, two, or more sections can be used in accordance with the needs of the train to be hauled. The leading unit only need be occupied by the motorman and assistant. With such a combination there is almost no limit to the amount of power which can be developed, as each unit is limited only by the heat characteristics of its motors. Regardless of the great power which can be supplied by such units, however, the service so far performed in this country is nearly all passenger, and little freight work is being done by electric locomotives on trunk lines. Of course, this statement is not strictly true if we consider such cases as the Baltimore tunnels of the Baltimore and Ohio, the tunnel under the river at Detroit, and the Sierra Nevada tunnel of the Great Northern, and other points where steam operation would be particularly objectionable; but, outside of a few special cases such as above mentioned, the electric service is confined almost exclusively to passenger transportation.

The Growth of the Coal Trade *

THE accompanying graphic representation will help to illustrate the statistics of coal production in the past twenty years.

To accomplish the large increase in the production and shipment of soft coal in the past twenty years the recourse to mining machines has been a prime factor. In 1891 6,211,732 tons was machine mined out of a total of 117,901,238. In 1901 60,611,582, tons was machine mined out of a total production of 225,828,149 tons, and in 1912 it is estimated 205,000,000 has been mined out of a probable total production of 440,000,000 tons.

It is very probable that the progress which we have made in the quantity of coal produced would not have been at the pace shown had it not been for the modern mechanical appliances.

Population has grown of course within the period covered by this review, but the increase has not been anything like in proportion to the growth of the coal trade. The figures as to gain in people follow:

The population of the United States in 1890 was 62,000,000; in 1900, 76,000,000; in 1910, 91,000,000.

The rapid expansion of the per capita use of coal is, indeed, a remarkable feature. The amount of coal (hard and soft) used for each unit of the population has increased from a small fraction to a round figure, the annual amount standing at 0.12 of one ton in 1840 as compared with 5.50 tons in 1910; multiplying something like 45 times. And even in two recent decades, a period of only 20 years, the increase has been most remarkable, the per capita coal consumption standing at 2.53 tons in 1890 as compared with 5.50 tons, in 1910.

It is these circumstances that give such great encouragement to those who regard the future of the American coal trade. It seems fairly certain that the population of the country will continue to grow for many years to come, and this being assured, and with such ample evidence as the past affords as to per capita increase in the use of coal, it is easy to conceive of really vast amounts being called for in future years. Twenty, thirty, or forty years from now the annual tonnage will be stupendous.

* Reproduced by courtesy of *Coal Trade Journal*.

Viewing the present firmness of market conditions, scarcity of labor, scarcity of cars, etc., may we not fairly conclude that the time has come when the supplying of the necessary coal tonnage is to be somewhat of a problem? May we not ask if we have reached the time when the buyer must seek the seller during a part of the year at least, and coal will no longer be a drug in the market?

1891
117,901,238 tons.

1901
225,828,149 tons.

1911
405,724,241 tons.

Figures Showing Relative Importance of Soft Coal Output During the Years Specified.

THE STATISTICAL SHOWING OF 1912.

The year 1912 promises to have an increase of something like 15 per cent over 1911. This may readily be deduced from the fact that the statements of several leading soft coal carriers show as follows:

Penn. RR.	tonnage increased	13	per cent	to	Aug.	31st
Norf. & West. .	"	"	25	"	"	"	"
Chesa. & Ohio.	"	"	19	"	"	July	"
Balt. & Ohio. . .	"	"	19	"	"	Aug.	"

Ohio Coal Traffic Association roads 47 per cent to July 1st Boston receipts to August 31st increased 11 per cent compared with 1911.

The anthracite tonnage for 1912 will fall below that of 1911 some six million tons but there will be a possible total of shipments aggregating 64,000,000 gross tons.

The bituminous tonnage of the country will probably amount to 460,000,000 net tons or an increase of 13 per cent over the production of the year 1911.

Our exports of coal will probably amount to 18,000,000 tons as compared with 17,432,723 tons in 1911. Shipments to the Northwest as shown by report of Sault canal for the season of 1912 to end of November were 14,409,453 tons as against 15,140,914 tons last year.

Some of the principal carriers of bituminous coal have made new records during the past year, the Pennsylvania system showing an increase of about 4,000,000 net tons, the Baltimore & Ohio nearly the same amount, the Norfolk & Western probably 3,400,000 net tons, the Chesapeake & Ohio about 1,050,000 and the Virginia Railway about 750,000 tons; Pittsburgh & Lake Erie nearly a million. The Ohio railroads have also done a very much larger business during 1912 and will show a possible increase of 7,000,000 tons. The other coal producing States have also scored an increase of perhaps 10 per cent during the current year over the figures of 1911.

Coke sales increased 25 per cent owing to better condition of the iron trade while prices for the product have at times shown such an increase in value that spot coke sold at $4 a ton at the ovens and contracts for the ensuing year are being freely entered into on the basis of $3.25 to $3.50.

Cold Springs Reservoir, Oregon.

Seepage Losses in Irrigation Systems*

Their Economic Significance

By E. G. Hopson

Jointing 46-inch Concrete Pipe, Umatilla Project.

In a report to the Comptroller of New York city made by John R. Freeman M. Am. Soc. C. E. in 1900 on the New York water supply attention was drawn in a very clear and forceful manner to the enormous proportion of waste incident to the operation of a great city water-works system. The subject had been dealt with before by other engineers and has been handled in a very comprehensive way by others since, but the writer did not recall at the time ever having seen the subject dealt with so comprehensively as in Mr. Freeman's report.

On page 38 of that report there is an interesting diagram showing the consumption of Croton water hour by hour during a typical week. By an ingenious interpretation of related but more or less disjointed bits of evidence it was shown that of a daily delivery of 115 gallons to each inhabitant of the city only about 40 gallons were really used and about 75 were wasted that is the proportion of use to waste was about 1:2.

It was further deduced that of the 75 gallons wasted 65 was in all probability needless waste and could be stopped by the adoption of proper measures. Naturally the question arose as to whether it was worth while for a city to continue to lavish vast sums in the construction of new works the greater part of the product of which would flow into the sea without benefit to any one or whether it would not be better policy to devote some of this money to internal improvements in works already built whereby savings equivalent in their effect to extensions of the supply system could be effected. Since the Freeman report was made much additional information has been gained on waste and its prevention in city water-works systems and it has been shown that the amount of what was termed by Mr. Freeman needless waste is not quite so great as has been supposed. The question as to whether enforced economy in use is better policy than increasing the capacity of the system is still to a large extent a debatable one.

The reasons in favor of moderate consumption and avoidance of waste apply with even greater force to an irrigation system than to a city water-work system in spite of the fact that the cost of the latter is relatively much higher than that of irrigation works. In a great city the cost of water-works is a comparatively light burden to the community the expense to the individual of an unrestricted supply of pure water being one of the smallest items in his annual expense account. On the other hand anything in the nature of restriction in use directly affects the personal convenience of each inhabitant and is resented; he often prefers paying an extra trifle in order to enjoy not only a sufficiency but an excess.

With an irrigation system conditions are different. Usually the supply is limited in quantity and a waste in one direction is immediately reflected by straitened conditions in another. A system of irrigation work is designed to supply a definite quantity of water to each acre of land. The engineer makes certain allowances for waste and losses by seepage and evaporation. If his calculations are correct the land receives a supply considered by him as sufficient but not excessive. If however through some unexpected cause the waste or losses are greater than were anticipated less land can be brought under cultivation than had been contemplated or farmers are compelled to get along with less water than had been considered necessary; hence the results are felt immediately and directly.

In the case of irrigation as with a water-works system losses can be classed as curable and incurable and it is the writer's purpose to consider briefly those classes as illustrated by works constructed by the Government in the Northwest during the last five or six years.

Roughly speaking incurable losses in irrigation systems result directly through water lost by absorption in the beds of reservoirs and evaporated into the air. Curable loss lies almost wholly in that absorbed in the beds of canals and other conduits.

In the great storage reservoirs required for irrigation works it is obviously an economic impossibility to accomplish anything in the way of preventing absorption or seepage losses in their beds. Whatever losses result through this cause must be accepted as unavoidable. The engineer however must be prepared to accept responsibility for results as his advice or decision on the all-important question of selecting or approving a reservoir site is the only safeguard against what may be disastrous loss if his judgment is ill-advised. For this reason the writer is illustrating the fundamental differences in conditions and results in four typical irrigation reservoirs built in the Northwest by the United States Government.

The East Park Reservoir is strictly a storage reservoir built on a branch of Stony Creek one of the Coast Range feeders of the Sacramento River. The dam site is a good one being a notch in a great conglomerate dike or ridge that runs through the country in a north and south direction and the dam is a solid masonry structure of the gravity type on an arched plan. The bed of the reservoir is practically wholly in the typical California shale. The dam was completed in 1910 and water was first stored in the winter and spring of 1910 and 1911. Weekly measurements are taken of the influent and effluent the storage and the rates of evaporation of the supply.

The maximum capacity of the reservoir is 45 000 acre-feet and the maximum area of water surface is 1,690 acres. Table 1 shows the results in the season of 1910-11, the season being from November 1st to November 1st in this and all the following cases.

TABLE 1.—EAST PARK RESERVOIR, 1910-11.

	Acre-feet.	Percentage of influent.
Influent	65,400	
Effluent and losses:		
Evaporation	7,100	11
Use, waste and surplus	58,300	89
*Seepage	0	0

* No appreciable seepage loss.

This reservoir represents the highest condition of efficiency of any of the four described. The records fail to show any seepage loss the only appreciable loss being that by evaporation; thus nearly 90 per cent of the water entering this reservoir is available for use.

The Cold Springs Reservoir of the Umatilla Project in Oregon is a good average reservoir from a Western standpoint. In the East it would probably not be regarded as a site of special promise. The dam is an earthen one nearly 4 000 feet long of a maximum height of nearly 100 feet. The general structure of the country is volcanic with vast overlying beds of stratified sands, gravels and hardpan. The valley constituting the reservoir site is the outlet of some 200 square miles of drainage area with little or no ordinary run-off. The reservoir is supplied by a feed canal some 25 miles long, diverting from the Umatilla River at times when the latter has available water. The capacity of the reservoir is 50,000 acre-feet, and its maximum area is 1,550 acres.

This reservoir was first placed in commission in the spring of 1908, and has been operated ever since. There are, therefore, four yearly records of results. In this case measurements were obtained with unusual accuracy, as practically all the inflow passed over a sharp-crested weir at the lower end of the feed canal, and the effluent was also carefully measured over another weir below the outlet gates. This reservoir shows losses ranging from 34 to 24 per cent of the influent during the four-year period. Judging by the record of the past two years, it would appear that a fair condition of stability has been attained in the regimen, in which about one fourth of the water entering this reservoir is subject to unavoidable loss through seepage and evaporation. Table 2 gives a summarized tabulation of the results.

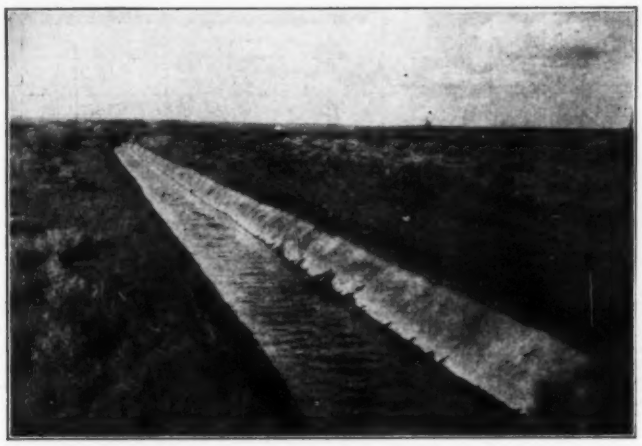
The Clear Lake Reservoir, in California, situated just south of the California-Oregon line, is a feature of the

* Copyright 1912. Am. Soc. of Civil Engineers. Paper read before the society December 4th, 1912, and published in the *Proceedings*, p. 1,223.

Mortar-lined Laterals and Concrete Structures, Umatilla Project.

Mortar-lined Lateral, Umatilla Project, Secures a Clear Channel.

Main Canal, Truckee Project, Concrete Lined.



Lateral in Umatilla Project, Mortar Lined.

Klamath Project. It occupies a great natural depression or sink, some 25,000 acres in extent, at the reservoir flow line. About one half of the bed consists of a natural sink of alkaline water known as Clear Lake which for ages has received and evaporated the surplus waters of Willow Creek. This reservoir was built by the Government principally for the purpose of holding back the waters of Willow Creek, in order to facilitate the unwatering of lands marginal to Tule Lake, a body of water into which Willow Creek ultimately discharges. The reservoir was intended to combine the purposes of a great

TABLE 2.—COLD SPRINGS RESERVOIR, OREGON.

Percentage of Losses Expressed in Terms of the Influent.

	1908.		1908–09.		1909–10.		1910–11.	
	Acre-feet.	Percentage.	Acre-feet.	Percentage.	Acre-feet.	Percentage.	Acre-feet.	Percentage.
Influent	20,366	..	42,820	..	61,526	..	72,273	..
Effluent and losses:								
Evaporation	2,400	12	4,295	10	5,333	9	6,252	9
Seepage	4,515	22	*4,021	9	*10,461	17	10,878	15
Use, waste, and surplus	13,451	66	34,504	81	45,732	74	55,163	76
Return flow	....	..	865	..	503	..	182	..

vaporating pan and a regulator of the diversion channel hat diverts the discharge of Lost River from Tule Lake nto Klamath River. More recent plans, however, have onsidered its possibilities as a source of irrigation supply. The capacity of the reservoir is enormous as compared ith the available water supply, being 450,000 acre-feet, ith an area of 25,000 acres. The dam on Willow Creek a rock fill structure some 30 feet high, which was comleted in 1909. There are two years' records of the action f this reservoir, as given in Table 3.

TABLE 3.—CLEAR LAKE RESERVOIR.

	1909–10.		1910–11.	
	Acre-feet.	Percentage.	Acre-feet.	Percentage.
fluent	141,000	..	225,000	..
ffluent and losses:				
Evaporation	80,000	57	88,000	39
Seepage	48,000	34	24,000	11
Use, waste, and surplus	13,000	9	113,000	50

The rate of evaporation in this vicinity has been estiated at a little more than 4 feet in an average year. It ill be noted that evaporation is the principal loss in the lear Lake Reservoir, as had been anticipated. The epage losses during the first year were heavy, but apparently, the marginal lands have filled up so that the losses in 1911 were comparatively moderate. It is important to note that in a year of copious run-off, like 1910-11, as much as 50 per cent of the supply was subject to unavoidable loss or waste, which, in this case, was intentional, the principal purpose of the reservoir being the disposition of surplus water, rather than its conservation for use.

The Deer Flat Reservoir, a feature of the Boise Project, in Idaho, presents different natural conditions from the three preceding types. It does not occupy a natural drainage valley or sink, but, on the contrary, is situated on a flat saddle between the hills, the lower ends of which are closed by two earthen dams. It has a maximum area at high water line of 9,250 acres, with a maximum capacity of 186,000 acre-feet. The reservoir derives its supply, as in the case of the Cold Springs Reservoir, through a feeder canal, known as the New York Canal, diverting from the Boise River some 10 miles southeast of Boise. The reservoir was first placed in commission in 1909, and has been in operation ever since. The bed consists in large part of silts, sands, and gravels, with a covering of from 3 to 5 feet of soil. Seepage losses in this case have been pronounced from the outset, and constitute the bulk of all losses. When the reservoir was first placed in commission almost 90 per cent of the water entering it was lost by absorption in the reservoir bed. In that year, however, the reservoir was only filled to one tenth of its capacity. During the next two seasons larger and larger quantities of water were introduced, and the proportion of losses has fallen appreciably, but still remains exceedingly high. During the last season about two thirds of the water entering this reservoir was subject to loss through evaporation and seepage. It may be expected that conditions will improve at this point as the adjacent and underlying strata of the reservoir gradually become filled by the constant application of water, but the extent and period of these ameliorating conditions are quite uncertain. A summarized tabulation of results follows:

TABLE 4.—DEER FLAT RESERVOIR.

	1909.		1909–10.		1910–11.	
	Acre-feet.	Percentage.	Acre-feet.	Percentage.	Acre-feet.	Percentage
Influent	64,000	....	130,000	....	230,000	....
Effluent:						
Evaporation	4,000	6	18,000	14	20,000	9
Seepage	55,000	86	80,000	62	140,000	61
Use, waste, and surplus	5,000	8	32,000	24	70,000	30

The foregoing records, while incomplete and faulty in many respects, are among the best obtainable in a new country, and in any event are instructive. The general problem of reservoir losses is often given less attention by engineers than its importance warrants. In many cases the dam site is apt to monopolize attention, and an engineer accustomed to deal with reservoir sites in Eastern river valleys, where the adjacent water tables are high and the losses are generally confined to evaporation, may be led to the commission of grave mistakes. A great deal has been said and written about return flow. One of the writer's earliest recollections in connection with reservoir studies was the discussions in the *Transactions* of the Society between Messrs. FitzGerald, Stearns, Fteley, and others, on ground-water storage of certain reservoirs in the East. Mr. FitzGerald's conclusions as to the general inadvisability of giving credit to the invisible storage of a reservoir are wise. Save under exceptional conditions, the writer doubts whether much, if any, additional draft can be made from Western reservoirs in excess of the visible storage. During the past four years the Cold Springs Rerservoir has absorbed some 30,000 acre-feet of water in its bed; it has apparently yielded back only about 1,500 acre-feet. The Deer Flat Reservoir has absorbed apparently 270,000 acre-feet, with little or no return.

It is important to note that in a reasonably good, representative, irrigation reservoir, such as Cold Springs, one quarter of the water turned into it is lost and that apparently under the most favorable circumstances as at East Park 10 per cent will be lost.

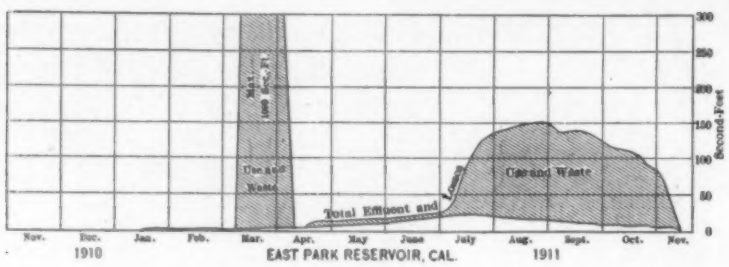
The main lesson to be derived from these few illustrations is that the geologic structure of the site should be given the most careful consideration as it is vital to determine in advance as nearly as may be the amount of reservoir losses and whether they are likely to be of a permanent character.

On the Umatilla Project, the cost of the irrigation works per acre of irrigable land is from $60 to $70; on the Truckee-Carson Project, about $40; on the Orland Project, about $50; on the Tieton, about $90; on the Sunnyside, about $50; and on the Klamath from $30 to $40; say an average of about $55. This is a fair indication of the general run of costs in large irrigation work in that part of the country, and is probably lower than the average costs on newer projects, either Government or private.

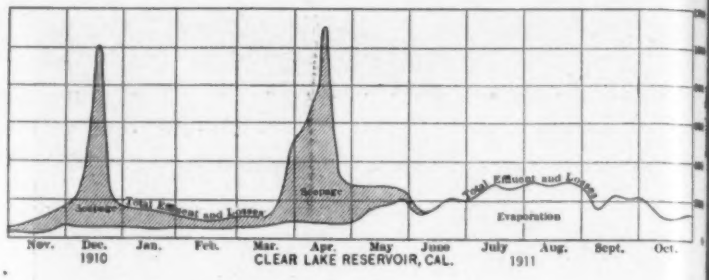
The various losses in the water-supply system, as expressed in percentages of water diverted, are as shown in Table 5.

Tieton Main Canal, Concrete Lined.

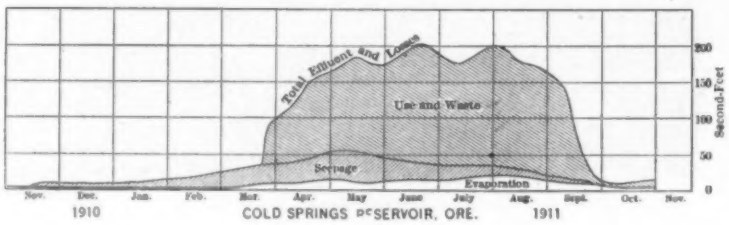
Typical Farmers' Lateral, Umatilla Project.



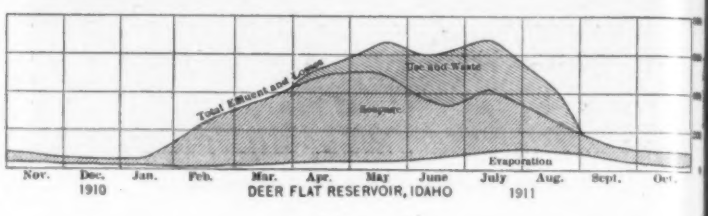
EAST PARK RESERVOIR, CAL.



CLEAR LAKE RESERVOIR, CAL.



COLD SPRINGS RESERVOIR, ORE.



DEER FLAT RESERVOIR, IDAHO

TABLE 5.—PERCENTAGES OF LOSSES.

	Reservoir.	Canal losses.	Totals.
Umatilla	20	32	52
Truckee-Carson	0	41	41
Orland	8	23	31
Klamath	0	48	48
Tieton	0	24	24
Sunnyside	0	27	27

These losses, running from one fourth to upwards of one half of the whole supply, are, unfortunately, not all. They include only the losses from the diversions down to the end of the regular lateral systems operated by the Government; but below these are the ramifications of the small ditches built by the farmers to distribute water to their farms. These farm ditches are usually small earthen trenches, in which heavy seepage occurs before the water actually reaches the crop. In some cases farmers use water-tight flumes and pipes for their local distribution, but the proportion of these cases is as yet comparatively small, although on the increase. It has been estimated that seepage losses in the farmers' ditches on many projects is not less than 50 per cent of the losses in the main canal and lateral systems. Allowing for the losses in the farmers' ditches not included in Table 5, the latter might be revised as shown in Table 6, it being understood that the losses in the farmers' ditches are merely the expression of individual opinion. not of actual measurement.

TABLE 6.—PERCENTAGES OF LOSSES.

	Reservoir.	Canal Losses.		Totals.
		Canals and laterals.	Farmers' ditches.	
Umatilla	20	32	15	67
Truckee-Carson	0	41	15	56
Orland	8	41	15	56
Klamath	0	48	15	63
Tieton	0	24	8	32
Sunnyside	0	27	7	34

Seepage losses on the Umatilla Project early assumed serious proportions owing to the sandy character of the soil and the gravelly substrata. With the unlined earthen ditches, as originally constructed, only about one third of the water diverted reached its proper destination. The works were costly, and the quantity of the supply was limited. Unless means could be found to lessen these losses, it was evident that the entire area could not be irrigated, and the building costs would not be wholly repaid.

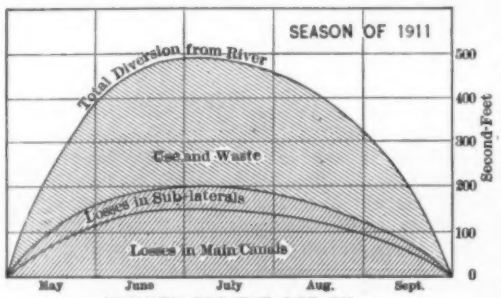
About equally severe proportional losses were found on the Truckee-Carson Project, in Nevada, and on the Klamath Project, in Oregon, but in both these projects there is more elasticity, due to their greater available supplies, and, in the case of the Klamath Project, to the small aggregate quantity used.

Losses on the Tieton and Sunnyside Projects are probably much more satisfactory than in the average well-constructed project in that vicinity, due, in the first case, to the complete concrete lining of the main canal and the tight character of the substrata of the irrigated lands. In the Sunnyside Project, the relatively small canal losses are due mainly to the fine texture of the soils.

It is probably a fact that in the average project from 40 to 50 per cent of the supply is lost by seepage in the beds of channels before it reaches the actual point of application. As the farmer is paying from $30 to $90 per acre for this water, the loss is very appreciable.

In Southern California valuable orchard lands have been under irrigation for a generation. Crop values have been very high, and, in many cases, the water supply has been so limited that effective measures toward conservation have been enforced On many projects in that region the distributing channels are lined with concrete, or pipe is used liberally. The high values of lands and the scanty water supply have rendered these measures not only desirable but necessary. Strict economy in use has also been enforced, for the same reason, but, in the newer projects in the Northwest, where crops of lower values obtain, it has not hitherto been seriously regarded as feasible to resort to such expensive treatment. Conditions, however, have changed materially with regard to crop values, and many of the water supplies which appeared to be inexhaustible a few years ago are being rapidly fully appropriated, so that reasons for economy and waste prevention are becoming more and more cogent.

Some interesting experiments carried out under the auspices of the College of Agriculture of the University of California, in 1906, by B. A. Etcheverry, on various kinds of canal lining, including concrete, clay puddle, and oiled surfaces, are worthy of consideration. The object of these experiments was to determine relative costs and efficiencies of different classes of lining in reducing seepage and preventing the growth of vegetation. Without attempting to enter into the details of these experiments,[1] the general results showed that the concrete lining alone, although the most expensive gave assured results. The oiling, as would be expected, is very much cheaper than any other treatment, costing only about one quarter as much per square foot as concrete. During the first year it appears to be of some value in reducing seepage losses, measurements showing that the losses, as compared with those in an untreated earthen canal, are only about 40 per cent of the latter. The oil seemed to be principally valuable in preventing a growth of vegetation. The clay puddle lining gave somewhat better results in preventing seepage than the oiled surface. The mortar and concrete linings, however, prevented from two thirds to nine tenths of the total losses, and, of course, entirely stopped the growth of vegetation.



KLAMATH PROJECT, ORE.-CAL.

Apparently, the effect of the oil treatment is only temporary, and a year or two afterward, a re-examination of the canals in which the experiments were made showed that the growth of vegetation in the oil-treated canals was equal to that in those untreated, and in all probability the seepage losses were also as great.

In 1910 and 1911, a lateral on the Umatilla Project was lined with mortar, 1 inch thick, and careful measurements were made to determine the losses. The lateral had been selected for lining on account of the very porous character of its bed and in order to reduce seepage loss. With the lateral closed at the ends by dams, measurements showed that the water surface lowered about [illegible] foot each day in the lined ditch, and by applying this rate of loss to the canal system as a whole, making due allowance for velocity of flow, it was computed that the aggregate seepage loss in the project, if all the canals were lined, would be about 5 per cent of the supply. With the unlined system the loss is close to 50 per cent. Subsequent measurements have confirmed the above, and, from these and other data, the conclusion has been reached that seepage losses can be kept down to less than 10 per cent of the amount diverted, if good linings are placed.

During the past two years much canal and ditch lining has been placed on Government projects in the Northwest. These linings are from 1 to 4 inches thick, depending on the size of the canal and the conditions. The heavy linings are of regular sand and gravel concrete having about 1 part of cement to 8 parts of sand and gravel. They are generally placed without forms the sides of the channel being trued up and a rather dry mix being used. The cost has usually been about $6 per yard. The great bulk of the ditch lining however has not been of regular gravel concrete but of mortar which is usually composed of 1 part of cement to 4 parts of sand. Before placing the mortar the ditches are carefully trued up by running a movable form or templet along their course and wetting and tamping the earth around the form. Immediately after the form is removed the mortar is placed and kept damp until it has set well. It is jointed usually at about 4-foot intervals in order to take care of temperature shrinkage. This lining is done with much rapidity by experienced gangs. The materials are mixed in small portable gasoline-driven mixers and the completed canals are kept full of water. The costs of work of this kind carried out on a fairly large scale for linings 1½ inches thick reinforced at the top by an extra heavy curbing run from 55 to 60 cents per square yard including of all administrative and engineering charges and of the earthwork. In general, the cost of the earthwork is about one third of the entire cost.

Take, for example, a small lateral of the Umatilla Project lined in this way during 1911: The length was 12,400 feet; the ditch dimensions were 4 feet wide at the bottom, and 4 feet deep, with side slopes of 1¼ to 1; the entire cost of the work averaged $1 05 per foot. Comparing a small ditch thus lined with an unlined one, the former will cost from three to four times more than the unlined ditch, but one of the economic advantages which the lined ditch possesses is the greater velocity of flow possible and the consequently smaller cross-section area of the channel. Another important advantage of lined ditches is the avoidance of drop structures. It is surprising what a large proportion of the total cost of ditch building goes into drop structures which are necessary in order to keep velocities below the eroding point in an earthen channel. With lined channels high velocities are not only possible, but desirable, in order to keep the channel clean.

[1] "Lining of Ditches and Reservoirs to Prevent Seepage Losses," *Bulletin* No. 188, Agricultural Experiment Station, University of California.

Total Diversion from River and Reservoir
Use and Waste
Losses in Farmers' Sub-laterals
Losses in Main Canals
Second-Feet
Mar. Apr. May June July Aug. Sept.
UMATILLA PROJECT, ORE.

TIETON PROJECT, WASH.

Note:-Practically no losses in Main Canal

As an illustration of what proportion the cost of structures in a distribution system bears to the entire expense of the latter, figures taken from the Orland Project in California are given. This territory is notably free from topographic irregularities, and the earth is firm and good for building purposes. The proportion of cost of structures, therefore, would be expected to be small.

The lateral system covers 14,000 acres, and includes 54 miles of ditches ranging in capacity from 12 to 75 second-feet. Very little ditch lining has been placed, but the structures are all of concrete, the cheapest building material. The cost totals are as follows:

Excavation work	$64,376
Structures	57,632
Total	$122,008

The structures included in these cost totals comprise the following types:

Checks and drops	$20,885
Turn-outs	12,901
Bridges	9,972
Railroad crossings	6,924
Special structures	5,805
Spillways	1,143

Checks, drops, and turn-outs total $33,780, or 28 per cent of the entire cost of the lateral system. All this cost could not be obviated by lining the system, but certainly a very large proportion could.

With a smaller cross-sectional area, the saving in drop structures, and the more direct and economical location possible in the lined ditches, the actual difference in cost per acre of land served by lined or unlined canals is comparatively small. It will generally be found to be less than $10 per acre, in many cases less than $5. If one takes into consideration the operating economies, the lined laterals have a distinct advantage by their freedom from breaks, seeped banks, and growth of vegetation in the channels, all of which should admit of a material reduction in operating costs. If these latter savings could be calculated from an investment standpoint and capitalized, any advantage in first cost of the unlined ditches would probably disappear, and a substantial margin be shown on the other side.

While considering canal lining, it would be well to give a little attention to the merits of pipe work in a distributing system. Large quantities of pipe have been used in the distributing systems of the Umatilla, Tieton, and Sunnyside Projects. The great bulk of this pipe is of concrete, both reinforced and plain, in sizes running from 54 inches down to 12 inches in diameter. The sizes below 24 inches have been usually made by the dry process, the reinforcement consisting of outside wire winding under tension. The larger diameters have usually been wet mixed, the pipe being manufactured in yards and hauled and laid like cast-iron pipe. Some of these lines of pipe are of great length and work under heads running up to 110 feet. They have always given satisfaction, from every standpoint. A distribution system consisting wholly of concrete pipe would be undoubtedly the most satisfactory from an operating standpoint, and although the first cost would be comparatively high, it might in the end prove to be more truly economical than the open-ditch system. With concrete pipe seepage losses are practically negligible. A number of tests of different lines of 4-foot pipe, under operating conditions, show the following, all this pipe having a shell 3 inches thick:

	Length.	Head.	Average seepage per mile.
1	4 700 ft.	39 ft.	0.07 sq. ft.
2	5 400 "	28 "	0.05 " "
3	3 600 "	19 "	0.04 " "
4	9 800 "	85 "	0.20 " "

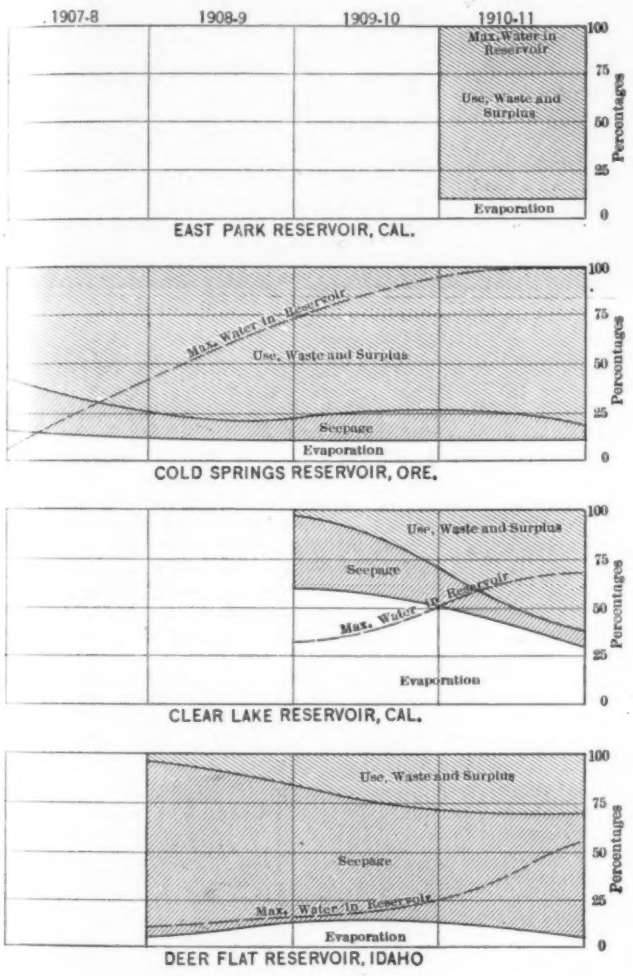
Apparently the loss per mile in pipe of this size is nearly directly proportional to the head and averages about 0.02 second-feet per mile for each 10-foot head carried on the pipe. A pipe-distributing system of concrete throughout under an average pressure head of 50 feet with delivery to each 40-acre subdivision would thus only lose about 1 per cent which is practically negligible. Taking the average of the six projects quoted the average cost of the irrigation works would be $55 per acre with an average combined loss in reservoirs and canals of about 50 per cent of the entire water supply. Of the latter about 6 per cent is practically incurable reservoir loss; the remaining 44 per cent has been classed as curable, that is the great bulk of it can be cured or prevented if economical conditions render such action wise.

Should the ditch systems of these projects be wholly lined with concrete or pipe the losses might be reduced from 44 per cent to 10 per cent or less, a net saving of 34 per cent say one third of the whole supply. It is evident therefore that either the systems could be extended to cover about one third more area, or if such land is not available the works might be constructed of smaller dimensions and at less cost. In the case of works already built the latter alternative is inapplicable and is merely illustrative of what might have been done but cannot be helped now. The lesson however should be applied to new work. In cases where new lands can be taken in under existing works consideration should be given to the possibilities of extension by lining the present systems.

Suppose for example a project of 20 000 acres costing $55 per acre or a total of $1,100,000; if by lining the ditches the irrigable area can be increased to 27,000 acres there will be first an additional cost for the new laterals with lining which has been found to be about $18 per acre in a fairly difficult country or for the 7 000 acres an additional construction cost of $126,000 will be necessary. Secondly there will be the cost of lining the present ditch system covering 20,000 acres which taken at $12 per acre would mean an added charge of $224,000. The gross cost of the extended project therefore would be $1,450,000 or an average cost of $54 per acre. This apparently does not result in a material reduction in the acreage cost but the great advantage lies in rendering available for profitable use the larger areas of land the conservation of the water supply, and the avoidance of drainage evils referred to later. As a matter of fact the process of extending a project already constructed with unlined earth canals by the subsequent lining of ditches is always much more expensive than if constructed *de novo* with the entire system lined.

In the case of a proposed large extension of the Umatilla Project it is planned to line the entire canal system from the head-works down to the minor ramifications of the distribution system delivering to each 40-acre subdivision. At no point in the system will the water be exposed to avoidable seepage loss and when the headgates at the reservoir are opened the Government will have the assurance that more than 90 per cent of the supply will actually reach the cultivated fields.

Closely connected with the question of canal losses is the drainage problem. On nearly every irrigation project large and frequently increasing areas will be found subject to the rise of ground-water. The principal contributing influence in most cases is the seepage loss from the lateral systems although a proportion of course is due to over-irrigation of the fields. On the Sunnyside Project in Washington some 4 000 or 5 000 acres of the best land was seriously affected a few years ago, large areas having been practically forced out of cultivation. In this case the Government was compelled to build a deep channel at a cost of some $340,000 mainly for the purpose of affording an outlet to the surplus water. On the Minidoka Project in Idaho the drainage feature is one of the most serious problems. At Umatilla the seepage water accumulating below the project in the Umatilla River has increased the summer flow some 100 seconds-feet and has rendered necessary the excavation of extensive drainage ditches through the lower lands. At Klamath some $40 000 has been expended during the past three years on this account and on the Truckee-Carson Project it is planned to expend not less than $400,000 in addition to the large sums already disbursed. There is no question that much relief from this increasing danger will be experienced by eliminating from the ground-water accumulations the bulk of the canal seepage. It is the writer's belief that as time goes on it may even be found necessary for legislatures to require canal systems to be lined or otherwise protected from seepage loss not only in the interests of the investor and water user but as a reasonable measure of conservation when water supplies are limited. As an engineering and business policy it is well in the front rank and should be considered by all who are building new works or operating and extending those already constructed.



Modern Engineering in an Ancient Eastern Capital

The New Pontoon Bridge Over the Golden Horn, Constantinople

By F. C. Coleman

This View Shows the Movable Span in the Act of Being Swung Out.

THE new pontoon bridge over the Golden Horn, built by a German firm, is of special interest as indicating how a traffic problem vital to the interests of the Turkish capital has been solved. The present structure, which directly connects Galata with Stamboul, replaces the pontoon bridge built some forty years ago on the same site (see Fig. 1), and which in its turn must have replaced quite an indefinite number of wooden structures. The Golden Horn is, at the site of the new bridge, about 1,542 feet wide, and the adjacent thickly populated and busy city of Stamboul, the focus of a large railway and shipping trade, is the seat of commerce for the West and East of the Old World. The terminus station of the Oriental railway is at no great distance from the bridgehead at Stamboul. Passenger boats, connecting with the Antoli railway terminus and with the residential quarters and places of interest on the European and Asiatic shores of the Bosphorus, Sea of Marmora, and plying to the Prince Islands and up the Golden Horn, berth alongside the bridge. Another bridge is situated about half a mile up, but on account of its unfavorable approaches is little used, so that almost the whole of the traffic—which is considerable—is diverted to the new structure. When the scheme was under consideration, the imagination of the public of Constantinople knew no bounds, and the Eastern mind had formed its own conception as to what the new bridge should be, the ideal focussing upon a single span bridge built sufficiently high to accommodate ship traffic and provided with lifts and moving foot-paths! Other visionary experts put in a plea for a tunnel and others again for a dam, but evidently none of these ever considered that the scheme had a financial aspect. In justice to the technical advisers of the Turkish Government it must be said that they took no share in the chimeral schemes put forward and with an eye to the facts of the case determined upon a pontoon bridge. A factor of first importance in the design was, in consideration of the low-lying banks, the keeping of the gradients of the bridge as flat as compatible with the clear head-room required by boat traffic. Further, berthing arrangements had to be made for passenger boats, and as no better solution than the then-existing one of lying hard by the bridge and readily accessible therefrom presented itself, this was adhered to. In consideration of the fact that the old bridge offered no important obstruction to the traffic between the inner and outer harbors it was not deemed advisable to go to increased costs for improvements in this direction. These features in themselves warranted the selection of a pontoon bridge, which was further supported by a consideration of the prevailing local conditions. The difficulty and expense of constructing piers or tunnels may be judged from the fact that the depth of water is approximately 130 feet and that the substratum on both banks to a depth of 230 feet is silt. Tidal variations do not occur and the maximum change in water level is 1 foot, which is chiefly to be attributed to the wind in the Sea of Marmora. Work was begun in the summer of 1910. The abutments were built without interruption of traffic on the old bridge, and the floating spans were erected some distance up the Golden Horn opposite the holy mosques of Islam at Ejub. The work occupied about two years, and necessitated the putting together of about 8,000 tons of constructional steel work. The distance between abutments is 1,530 feet and the width between railings 82 feet, made up of a roadway 46 feet wide and two footways each of 18 feet. For ship traffic with the bridge closed two clear openings each of 39 feet are provided, the clear headway with traffic being 17½ feet, while with the middle opening span swung round a clear throughway of 205 feet is obtained. The steepest gradient on the roadway, the surface of which follows a parabolical curve, is 1 in 26.5, and this at the ends. The pontoons are arranged in two rows parallel to the longitudinal axis of the bridge. The braced cross-girders are supported on the transverse bulkheads of the pontoons at four points, the end posts being set in such a distance from the outside edge of the footway that a clear covered passage way of 5.6 feet is obtained between the board walls of waiting rooms built under the bridge and the outside edge of the cantilever footway. The cross girders in the middle of the pontoon sections are strongly braced together which gives the whole construction the requisite rigidity. The roadway is formed upon steel troughing carried upon longitudinal girders. The composite parts of the structure are of necessity well connected together so that movements relative to each other, outside those resulting from angular deflections due to loading or to changes of water level, do not occur. To this end hinges connected to adjacent pontoon units and with axes parallel to transverse axis of the bridge and arranged as near rail level as possible are introduced to prevent relative vertical movement; while cover hinges on the parapet girder obviate longitudinal movements, and, finally, teeth on adjacent border sections and engaging in each other prevent relative transverse movements. In opening, the middle span is swung through an angle of 180 degrees on the Golden Horn side and toward Galata by means of a boat fixed to the free end of the span, provided with propellers fore and aft and operated electrically, the controller being fixed on the bridge railing. The locking arrangements, consisting of bolts interconnecting fixed and moving spans, to prevent, in the closed position, movements up or down stream, are also operated from the same point. The covering plates decking the clearance between fixed and moving spans are built up in straight sections, and so interconnected with the locking mechanism as to fold back on withdrawal of bolts. Should occasion arise the locks may be operated by hand and the moving span swung round by a tug. Relative transverse movements between the moving and adjacent spans are prevented by means of hinges situated on the parapet girder on the Golden Horn side, and these are designed to allow for any rolling or pitching that might occur when the middle portion is disconnected. The center span pivots upon the hinge on the Galata side, while on the Stamboul side the hinge is arranged to take up longitudinal movements. In opening the bridge the latter hinge is drawn out of its socket by a hand-operated winch and in closing falls into position by its own weight. The locking bolts and hinges are situated as near the roadway level as possible. The longitudinal play on the one hinge is arranged to take up temperature differences and any movement which may result by the bridge being put out of alignment in storms. In order to avoid strain the bridge is pivoted axially on the abut-

The Floating Spans Were Erected Some Miles up the Golden Horn, Opposite the Mosques at Ejub.

In This View the Movable Span of the New Pontoon Bridge is Seen Completely Swung Out.

ments and the necessary clearance allowed between it and the end walls. The abutments which chiefly serve as approaches were sunk pneumatically and are not called upon to carry much more than their own weight, which is kept as low as possible by the provision of recesses. In consideration of the unfavorable substratum conditions, anchorages extending an appreciable distance into the banks are provided. On the Bosphorus side of the bridge seven landing jetties are provided, while on the opposite side two are arranged for the ordinary traffic, and one for the Turkish marine, police and bridge authorities. The architectural treatment of the scheme, which was arrived at in collaboration with the chief engineer and city architect of Constantinople, is somewhat unique and well defined in the general elevation. The opening span, built up as a double gate with its recesses, inscriptions, and projections, rather diverts one's thoughts from steel as one is accustomed in the Near East to seeing such treatment only in mosques and in marble. If this bridge scheme, however, appears to be a contradiction between form and material, it should be borne in mind that the introduction of a structure of purely European type would scarcely have been in perfect harmony with its surroundings.

A German Police Telephone

Scientific Aids for Patrol Service

By Dr. Alfred Gradenwitz

In view of the steadily increasing extension of great cities, the public safety service is daily beset with new difficulties. As, moreover, there is frequently a lack of policemen, the safety, especially in the outlying districts, often leaves much to be desired. In fact, there is an undoubted necessity of assisting the work of patrolling policemen by some means enabling them to communicate with headquarters from any point of their district.

This is achieved by the police telephone recently designed by a manufacturing firm of Berlin, an apparatus specially adapted to its purpose which on account of its cheapness and simplicity will greatly assist the police on duty.

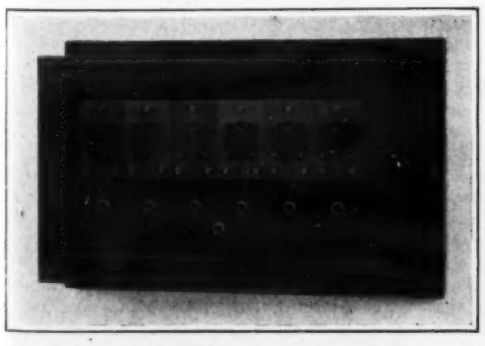
The apparatus as represented in the accompanying figures contains a microphone and a telephone receiver. These two parts are combined in so compact a form as to reduce the whole system to the size of a watch; in fact, it can be readily carried in a vest pocket. The active parts are inclosed in nickel-plated metal boxes which after use are placed upon one another and by means of a bayonet lock, are readily coupled together by a one fourth turn. The electrical communication is effected by a substantial cord. The microphone is carried in a small leather pouch.

In order to allow this apparatus to be connected up to a telephone line, contact boxes, such as represented below, are provided in the streets. These are small cast-iron boxes, the lid of which is opened by means of a key carried by the policeman. They comprise in their interior two contact rods and an elastic hook for suspending the microphone during conversations.

These contacts are arranged in the streets at intervals of 300 to 400 meters apart, and are connected together and with the nearest police station by cables protected against injury by iron pipes. The locks of the contact boxes cannot easily be opened by means of a picklock; they are of substantial design, and their water-tight fitting warrants perfect insulation of the electrical parts.

At the district police station is installed a telephone post, resembling an ordinary wall apparatus, but for an annunciator disk arranged at the front and which is actuated by attaching the receiver to its hook, thus throwing in an alarm bell. Whenever several lines converge in a larger district station, a small switchboard is used for indicating the line calling up. The operator then connects his apparatus by means of a plug with the line in question, after which telephone conversation can be proceeded with. This switchboard also allows the street apparatus to be connected up to the private telephone line of the police head station, as well as to the municipal telephone system. It is thus seen that each street contact enables the policeman to communicate with the district station as well as with any apparatus connected to the general telephone system.

The Contact Box for Field Use.



The Switchboard at the Police Station.

One of the Field Stations of the Telephone.

A double-strand common cable is required for connecting up about forty to fifty contact boxes. There is no difficulty in using to this effect a double strand of the municipal cables which are installed in practically all main streets of German cities. In those suburban districts which have as yet no cables, overhead conductors are used, lead cables protected by iron pipes serving for connection with the contact boxes. In public gardens and parks the contact boxes are preferably attached to trees or lantern posts.

The Transmitter and Receiver at the Station.

The Pocket Transmitter in Its Leather Bag.

Peroxide in Toilet Preparations

In a paper read before the northwestern branch of the American Pharmaceutical Association at Winona, Minn., J. S. Brewer made the following observations concerning the use of peroxide of hydrogen, or hydrogen dioxide, in cosmetics and other toilet preparations.

Peroxide has come into considerable prominence as an addition to greaseless creams which are marketed as peroxide creams. In making these creams the solution is usually employed, as the peroxide of various metals are rather coarsely powdered, and make the cream gritty. Peroxide creams are unsatisfactory because the peroxide rapidly decomposes after being combined with organic matter such as stearic acid. In addition to this most greaseless creams or peroxide creams are slightly alkaline, which neutralizes the acidity of peroxide, causing its rapid decomposition.

Peroxides of the metals, such as calcium, magnesium, zinc, sodium and strontium, are much used in dental preparations. Their stability in dental pastes is questionable, but in powders they are of considerable value, only giving up their oxygen in the presence of moisture. These metallic peroxides are also employed with advantage in deodorizing powders.—*The Chemical World.*

Engineering and the Amenities*

The Beauty of Appropriateness

By Prof. Archibald Barr, D.Sc.

One of the great engineers of the past, Leonardo da Vinci, prefaced a collection of observations on various themes, including the mechanical arts, with the remark: "Seeing that I cannot choose any subject of great utility or pleasure, because my predecessors have already taken as their own all useful and necessary themes, I will do like one who, because of his poverty, is the last to arrive at the fair, and, not being able otherwise to provide himself, chooses all the things that others have already looked over and not taken, but refused as being of little value. With these despised and rejected wares—the leavings of many buyers—I will load my modest pack and therewith take my course." These words describe, with some approach to exactitude, the position in which I find myself, and may form a fitting introduction to an address that will be discursive rather than systematic, and perhaps more critical than constructive.

It may be less true to-day than it was four hundred years ago to say that all important matters concerning the existing state of the mechanical arts have been dealt with in spoken or written addresses. Each year there might be found sufficient subject matter for a general survey of the ground that has been covered or a sketch of what lies before us. But each important advance is now-a-days recorded as soon as it is made, and I do not feel that I have any special call to assume the rôle of the historian, nor can I claim any right to don the mantle of the prophet.

A president of this section who is not disposed to deal with the general aspects of the progress being made in the department of science allotted to us can usually find a large enough subject for his address within the limits of that part of our wide field with which his own work has been more particularly identified, and it might be expected that I would devote my address to a discussion of the conclusions at which I have arrived during thirty-six years of practice and experience in the teaching of mechanical science. But so much has been said of late on the training of engineers, and so many divergent and even irreconcilable opinions have been expressed regarding the lines such training should follow, that I feel sure I shall be relieving the apprehensions of some of my audience if I begin by stating that I do not propose to inflict upon you a discourse on that threadbare theme. There are limits to the endurance even of those who practice a profession well calculated to inculcate the virtues of patience and forbearance.

When we have as president of the section one who has broken new paths in the exploration of the territory assigned to us, or to whose labors the fruitfulness of some corner of the domain may be chiefly attributed, we would hardly be disposed to tolerate the omission from his address of an account of his own special work in investigation or practice, and the developments to which it is leading. But while, no doubt, every worker is the chief authority on something or other, the plot he cultivates may be so restricted in area, and its products may bulk so little in the general harvest, as to form no suitable topic to engage the attention of his fellow-workers on such an occasion as this.

When an engineer leaves practice in the great, and takes to devising and the production of what are usually referred to specifically as "scientific instruments"—though all machines and mechanical appliances may properly be classed as such—his colleagues in the profession may be disposed to look upon the change as a degeneration of the species. Naturally, I am not disposed to accept such a verdict. Remembering the careers of those who did most in the founding of the various branches of present-day practice, I am quite prepared to accept as applicable another phrase borrowed from the language of the biologist, and to let it be called a "reversion to a more primitive type." But instead of dealing with the narrow branch of applied science, with which my own practice is chiefly connected, I prefer to utilize the short time at my disposal to make some observations upon a larger and more general theme. The thesis which I propose to uphold may not fall very obviously within the scope of the original aims of the British Association, but it has at least an intimate bearing on the work of those concerned with the applications of mechanical science.

Tredgold's oft-quoted definition of engineering as "the art of directing the great sources of power in Nature for the use and convenience of man" may well be taken, and often has been taken as a text upon which to hang a discourse on the importance of the profession to which many of us belong, the leading part it has played in the process of civilization, and the dependence of the world to-day on its activities. But the words suggest failures as well as achievements, and responsibilities no less than privileges. The definition suggests that the engineer not only fails in his vocation if he does not accomplish something for the use and convenience of man, but, further, that he acts contrary to the spirit of his profession if he directs the sources of power in Nature to the unuse[1] or inconvenience of man; and surely we must understand by "man" not the engineer's immediate client, but mankind in general. The works of the engineer are to be used by some people; they have to be endured by all.

Taking the highest view of our calling—and surely we do not hold that ours is in any sense a sordid or selfish vocation—the engineer fails in the fulfilment of his duty in so far as his works are detrimental to the health or destructive to the property of the community, or in so far as they are unnecessarily offensive to any of the senses of those who are compelled to live with them. There has been too great a neglect of such considerations. The medical practitioner is held to be negligent of his duty if he acts solely in the immediate interests of his patient, and does not take due precaution to guard against the spread of disease or the offence of the community by the exhibition of unsightly forms. We should take a high view of our responsibilities.

In his presidential address to the Association last year Sir William Ramsay said that the question for the engineer has come to be not "can it be done?" but "will it pay to do it?" The answer to this question in respect to any particular proposal depends on the width of view we take in answering two preliminary questions: Whose interests are we to consider? and what do we mean by paying? Of course, there are limits that must be set in answering each of these; my present contention is that these limits are usually much too narrowly drawn. A road surveyor may save a few pence or shillings to his County Council by leaving a piece of newly metalled road unrolled—because the clock strikes the hour for retiring—and may thereby cause expense amounting to pounds, it may be to hundreds of pounds, through damage to motor cars or the laming of horses—not to speak of loss of life or limb—to the users of the road, who are, after all, the *clientele* he is there to serve. Does it pay? The authorities of a city will spend large sums on the adornment of the streets with stately and ornate buildings and on the purchase of works of art—and rightly so, though comparatively few of the citizens can appreciate or even give themselves the chance of appreciating them, while they will tolerate, or even be directly responsible, for the running on these same streets of quite unnecessarily ugly and noisy tramcars, and congratulate themselves on the drawing of a paltry income from the display of hideous advertisements that are constantly before the eyes of the whole community. Does it pay thus to separate æsthetic from utilitarian demands and interests?

It is too much to assume that engineers could meet all the reasonable demands of their immediate clients without producing at least temporarily, secondary effects that may be of inconvenience to some members of the community. Bacon, indeed, said that "The introduction of new inventions seemeth to be the very chief of all human actions. Inventions make all men happy without either injury or damage to any one single person." But Bacon was a philosopher and dealt with ideals rather than with hard facts, and in his times inventors had not yet begun to dominate all the elements of our physical environment. Had he lived to-day beside one of our country roads he might have had something to say, in another key, regarding motor cars and dust; or had his lot been cast in the proximity of a great center of industry he might have modified his conviction of the universality of the benefits conferred by the inventor. He might even have been disposed to agree with a literary man of to-day who is reported as asserting that "The universal and blatant intrusion of Science into our lives has resulted in a total disappearance of repose." Isolated and unqualified statements such as those I have quoted are like proverbs—you can always find two that are directly opposed. The truth lies about midway between these extremes, or rather there are aspects of the facts in regard to which one is an approach to the truth, and aspects in which the other has some justification. Our aim should be to make Bacon's dictum have more of truth and Mr. Stephen Coleridge's assertion have less foundation in fact. And the outlook seems to me to be a very hopeful one, though to be able to take an altogether favorable view of the tendencies of the present time one must be an optimist of the true order—"One who can scent the harvest while the snow is on the ground."

When we examine into the immediate causes of the injuries and inconveniences that result from our activities we find that they are due in all, or almost all, cases to failures rather than to successes. The more completely the engineer achieves the primary end of his work the less is the damage or injury that can be laid to his charge. If it can be shown that this is a very general law, as I think it can be, we may look forward to the elimination, as a direct result of progress in the mechanical arts, of the nuisances and inconveniences for which, in some measure at least, we must accept responsibility. And not only so, but the converse will be equally true—the more we keep in view the removal or avoidance of anything that can cause offence, the more rapidly we shall advance in the attainment of the primary ends at which we aim. Consider, by way of example, the nuisance to which I have referred, and of which we hear so much—the raising of dust by motor cars. I shall not discuss the debated question as to how far the motor car produces dust, or only distributes it, nor shall I deal in detail with the possible remedies. We hope to have a paper on the subject at this meeting from one of our leading authorities. For my present purpose it suffices to point out that it is no part of the function of a road surface to fritter itself down into dust under traffic of any kind. The ideal road would be one that would not wear at all, and the nearer we approach this ideal of a permanent road surface the less will be the inconvenience caused, not only to those responsible for the upkeep of the road, but to the general public. And, conversely, the more attention we give to the devising of a dustless road the more rapid will be our advance toward the provision of one best suited for all the purposes which a road is intended to serve. We had dusty roads before the motor car came into being, but the demand that is being forced upon the engineer to eliminate this nuisance is leading to an improvement of our roads for all users. The inventors of the automobile will yet merit the thanks even of those who, bemoaning the blatant intrusion of science into our lives, may discard the railway train and the motor car and take to the stage-coach of their grandfathers with a view to the recovery of some of the lost repose.

Again, the combustion of fuel does little harm to anyone; it is the imperfection of the combustion that is the main cause, almost the sole cause, of injury to health, to property, and to the amenity of populous centers. Of course, one knows that smokeless combustion is not necessarily, nor always, the most economical, but that is only because we have not yet learned how to use fuel in anything like a perfect manner. But all the tendencies at the present time are toward improvement, and the more attention we pay to the elimination of the smoke nuisance the more rapid will be our progress in the economical use of one of the most valuable of our inheritances. It is therefore clearly the duty of every engineer who has to do with power or heat production—for the credit of his profession and even in the interests of his immediate clients—to consider the use and convenience of all who can be affected by the work for which he is responsible. The time is not far distant when the direct burning of bituminous coal in open grates will be looked upon as not only a source of serious harm, but as a culpably wasteful practice. Great progress has been made in processes for the partial distillation of coal by which a free burning and quite smokeless fuel is prepared and valuable by-products (so-called) are conserved. If all engineers concerned with the design and application of plants in which coal is used had a due sense of their responsibilities to the community, progress would have been, and would to-day be, much more rapid; and economies would be effected that would, in themselves, amply justify the application of more scientific methods of utilizing the constituents of a very complex material, which we are too apt to look upon as merely a convenient source of heat—plentiful enough and cheap enough, as yet, to be used in a most wasteful manner. It will not be to the credit of our profession if it should require restrictive legislation not only to prevent a gross interference with the health and comfort of the community and the amenities of our centers of industry or of population, but to effect economies in the utilization of the chief of the sources of power which it is our function to direct to the best advantage of all concerned.

* British Association, Dundee. Presidential address to the Engineering Section.

[1] We have no word to denote very clearly the negative of *use*, as the term is here applied; *unuse* may serve for the present.

In other directions also we see that progress toward economy is leading to a reduction, and possibly to the entire elimination, of all the nuisances associated with the older methods of power and heat production. The great improvements that have recently been made in producer plants and gas engines have rendered out of date as regards economy at least the smaller sizes of steam plants which are so fruitful a source of injury and inconvenience to the community; and we now have engines of the Diesel and the so-called semi-Diesel types that can utilize natural oils and oils obtained in the distillation or partial distillation of coal not only with an efficiency hitherto unattained in heat engines, but "without injury or damage to any one single person"—except possibly the maker of inferior[2] plants.

Present indications point to the coming of a time in the near future when the power and heat required for industrial and domestic purposes will be distributed electrically in a perfectly inoffensive manner from large central stations, and even at these stations there will be no pollution of the atmosphere that could give the most sensitive of critics any just grounds of complaint against the intrusion of science into our lives. In his presidential address to the Institution of Electrical Engineers in November, 1910, Mr. Ferranti dealt in a most masterly way with this, which is, undoubtedly the greatest of the many schemes at present before the engineering profession. That address reads like a chapter from a Romance of Utopia, but, unlike most of the forecasts that have been presented to us of ideal conditions in a world of the future, the system which Mr. Ferranti sketches out and advocates with so much knowledge and convincing argument does not depend for its reasonableness on the postulation of a perfected humanity. It would not only provide vastly improved conditions of life for the community as a whole, but it would satisfy the more selfish aims of the users of power and the makers of machinery by increasing the economy of production and stimulating the demand for mechanical appliances. No doubt there may be some who will hold that to commend any worthy scheme to those who might carry it out by an appeal to their selfish interests is an altogether immoral kind of argument. I do not think so. Advancement of the race through benefits to the individual is, at least, not inconsistent with Nature's method of securing progress. However much we may desire to develop a purely altruistic spirit in men of all classes, we must meantime make the best of human nature as it is and recognize that the rapidity of our progress toward better conditions of life will be in proportion to the advantages that each advance can promise to those who would be immediately concerned in its realization.

It is just a hundred years since passengers were first carried on the Clyde in a mechanically propelled ship, and to-day—when they are not too completely obscured by smoke—we can see the successors of the "Comet" plying on that river with power plants of greatly superior overall efficiency, but showing little advance in regard to the combustion of the fuel. Had the emission of smoke from river craft been prohibited years ago, there is little doubt that engineers would have let few days pass without arriving at some solution of the problem of inoffensive powder production, and the demand for economy would have looked after itself. How much better it would be were engineers to take the wider view of their duties and responsibilities to which I have referred, and realize that they are acting contrary to the true spirit of their profession when they produce appliances that pollute the atmosphere for miles around to the hurt and inconvenience of those whose "use" they are intended to serve. But this year a ship has left the Clyde that we hope may be the forerunner of a new race which will obtain a higher efficiency than any of the direct descendants of the "Comet," and that will ply their trade without inconvenience to man or beast, who can claim some right to be permitted to enjoy an unpolluted atmosphere and the measure of sunshine which Nature—sparingly enough in those regions—intended to provide.

But there are injuries which we may inflict upon the community other than those to health and physical comfort. Every one, even the least cultured, has some sense of the beautiful and the comely, and is affected by the aspects of his environment more than he himself can realize. The engineer, then, whose works needlessly offend even the most fastidious taste is acting contrary to the spirit of his profession at its best. There has been far too great a disregard of æsthetic considerations in the every-day work of the engineer—we usually take a too exclusively utilitarian view of our calling. We should not be prepared to accept, as referring to the arts we practice at their best, the distinction drawn by a philosophical writer between "the *mechanical* arts, which can be efficiently exercised by mere trained habit, rote, or calculation" and "the fine arts which have to be exercised by a higher order of powers."[3] And I think it can be shown that a greater regard for artistic merit in our designs would not necessarily lead to extravagance, but in many cases would conduce to economy and efficiency. It is at least true—and much less than the whole truth—that greater artistic merit than is commonly found in our works could be attained with no sacrifice of structural fitness or of suitability for the purposes they are designed to serve.

There was a time when engineers made desperate attempts to secure artistic effects by the embellishment (?) of their productions with features which they believed to be ornamental. Fortunately, the standard of taste has risen above and beyond this practice in the case of most members of our profession and most of our clients. We are all familiar with illustrations of philosophical instruments and other mechanical contrivances of the early times that vied in lavishness of adornment—though not in artistic merit—with those wonderful astronomical appliances that were carried—as trophies of war!—from Pekin to Sans Souci. Many of us can remember a time when the practice had not altogether disappeared even in the design of steam engines, lathes, and other products of the mechanical engineer's workshop. I well remember in my apprenticeship days the building of a beam engine that was a triumph of ingenuity in the misapplication of decorative features. In place of the mildly ornamented pillars and entablature of Watt's design there was provided for the support of the journals of the beam a pair of A frames constructed in the form of elaborately molded Gothic arches flanked by lesser arches on each side, while the beam itself and many other parts were plentifully provided with even less appropriate embellishments borrowed from the art of the stonemason. It is some consolation to remember that the clients for whom the engine was built were not of this country, and that the design itself was not a product of the workshop that was favored with the contract to produce this amazing piece of cast iron architecture. We have all seen wrought iron bridges the inattractive features of which were concealed by cast iron masks—in the form of panelling or of sham pillars and arches with no visible means of support—that not only have no connection with the structural scheme, but suggest types of construction that could not, by any possibility, meet the requirements. Structures of this kind remind one of the pudding which the White Knight—with good reason when we remember the characteristics of his genius—considered the cleverest of his many inventions. It began, he explained, with blotting-paper, and when Alice ventured to express the opinion that that would not be very nice, he assured her that, though it might not be very nice *alone* she had no idea what a difference it made mixing it with other things—such as gun-powder and sealing-wax.

There are, and must always be, wide differences of opinion regarding what is good or bad in matters of taste, but we may go so far in generalization as to say that we can admire the association of elements we know to be incongruous only in compositions that are intended to be humorous. "All human excellence has its basis in reason and propriety, and the mind, to be interested to any efficient purpose, must neither be distracted nor confused."[4] But to be able to judge of the propriety or reasonableness of any composition we must have some knowledge of the essential qualities and relationships of its component parts, and excellence cannot depend upon an appeal to ignorance. We can quite imagine that the White Knight's pudding would appeal as an admirable and most ingenious concoction to one who lacked a knowledge of the dietetic value of blotting-paper and was willing to take for granted the excellence of gun-powder as a spice and of sealing-wax as a flavoring. No artist would be bold enough to include a polar bear or a walrus in the composition of a picture of the African desert, nor be prepared to consider as a legitimate exercise of the artistic imagination the depicting of an Arab and his camel wending their weary way across the Arctic snows. He would recognize the incongruity, and might even realize that it is only a lack of imagination or of true inventive power that could lead anyone to resort to such measures for the securing of a desired color scheme. These are lengths to which even artists will not go in the arrangement of elements in a composition. But an artist will secure a color scheme at which he aims by the introduction into his landscape of a rainbow in an impossible position, or of an impossible form or dimensions, or with colors arranged according to his own fancy, though in this there is a much more essential unreasonableness. A polar bear might be transported to the desert and an Arab might conceivably find his way to the regions of snow and ice, but a rainbow cannot wander from the place assigned to it by Nature, nor can it have other than the ordained form or dimensions or sequence of colors. No artist would paint a figure holding a candle and make the light fall on the side of the face remote from the source; but he will, and usually does, paint the moon illuminated on the side remote from the sun. Why? Simply because he has not before his mind the essential absurdity of the scheme, if indeed he knows why the moon shines. Artists who deal with Nature in any of its aspects may be commended to "mark, learn, and inwardly digest" Whistler's definition of their calling: "Nature contains the elements in color and form of all pictures . . . but the artist is born to pick and choose, and group with science these elements that the result may be beautiful." Whether or not we are to understand that Whistler intended to include an accurate knowledge of physical facts and phenomena in what he calls science, he cannot have meant anything less than sense.

So in regard to the arts of construction, we may say that mechanical science provides the elements of all structures, and the craftsman—be he called engineer or architect—is born to pick and choose and group with science these elements that the result may be useful, and not devoid of grace.

The only valid excuse for such departure from the fit and rational in painting or in structural design, as those which I have instanced, is ignorance on the part of the designer of the nature of the elements he employs or a lack of skill to devise a possible or reasonable arrangement of details that will secure the general effect he desires.

It may almost savor of sacrilege to quote in this connection from the writings of that "Wild, wilful, fancy's child" the story of whose eight short years of life and literary work Dr. John Brown has given in his charming "Pet Marjorie"—a record of perhaps the shortest human life that has formed the subject of a biography. But the lines are too pertinent to my purpose to be withheld, and the frankness of the confessions they contain of a childlike limitation of artistic power may be commended to those who practice either the fine arts or the arts of construction, and feel compelled to "trust to their imagination for their facts," or to resort to the association of incompatible details for lack of knowledge, or of ability to attain their ends by more reasonable means.

Marjorie writes of the death of James II.:

"He was killed by a common splinter,
Quite in the middle of the winter;
Perhaps it was not at that time,
But I could find no other rhyme!"

"Quite in the middle of the winter" describes August 3rd, 1460 A. D., with no wider license than we find assumed in the works of more experienced, if less candid, artists and craftsmen. Again, in her sonnet to a monkey—written, we must remember, when she was six or seven years of age—she acknowledges the compelling power of an artistic aim:

"His nose's cast is of the Roman:
He is a very pretty woman.
I could not get a rhyme for Roman
So was obliged to call him woman."

It may seem that I have wandered widely from my text; those who found discourses on texts usually do! But there is, or ought to be a closer connection than is usually recognized between the work of the engineer and that of those to whom we usually restrict the title of artist. There was no great gulf fixed between the fine arts and the utilitarian arts in earlier times. Some at least of those to whom we owe the greatest advances in the fine arts were eminent also in the arts of construction. We may claim such men as Michelangelo, Raphael, and Leonardo da Vinci as masters in the arts of construction as well as in those with which their names are usually associated. The separation of the beautiful and the useful is quite a modern vice. But much that I have ventured to say in the digression—if such it be—is applicable, with little or no alteration of terms, to the work of our own profession. The architect or engineer who, for the sake of effect, fills the space between the flanges of a beam or girder with slabs of stone or cast iron pillars and arches, that could not fulfil the function of a web, exhibits just the same lack of skill as Pet Marjorie owns up to—shall I say?—like a *man*. Such practices have no "basis in reason and propriety," and the employment of such "decorative features" is certainly not a "grouping of elements with science." It is said that "The highest art is to conceal art;" the lowest in matters pertaining to our profession is to conceal ill-devised construction with false and senseless masks. But what I have said has, I think, a sufficiently obvious bearing on the mechanical arts—I need not further point the moral.

There is an old maxim to the effect that "the designer should ornament his contruction and not construct his ornament." This is an admirable rule so far as it goes, but it should be subordinated to a higher rule, that he should ornament his structure only if he lacks the skill to make it beautiful in itself. A structure of any kind that is intended to serve a useful end should have the beauty of appropriateness for the purpose it is to serve. It should tell the truth, and nothing but the truth, and if its character be such that it can be permitted to tell the

[2] My typist in transcribing a rather illegible draft of this passage substituted for the adjective I have here used the less restrained, but perhaps equally appropriate one, "infernal," but I noticed this in time to amend the emendation. I had no intention to speak so candidly of any of the works of members of my own profession.

[3] *Enc. Brit.*, eleventh edition, article "Art."

[4] Mr. Duppa's "Life of Michelangelo."

whole truth, so much the better. It should be beautiful in the sense in which we commonly use the term with respect to a machine—we call a mechanical device beautiful only if it strikes us as accomplishing the end for which it is designed in the simplest and most direct way. Our works—like the highest creations in Nature—should be beautiful and not beautified. "Beautified" should be considered a vile phrase when applied to a work of construction, no less than when used to characterize a fair Ophelia. Artists accept the human form at its best as the highest embodiment of grace and beauty, but there is not a curve in the figure that is not the contour of some structural detail that is there for a definite purpose. The practice of resorting to extraneous adornments to minimize crudities of structural scheme had its rise—if I mistake not—in the comparatively recent times when culture and taste were at their lowest. It is specially characteristic not only of earlier times, but of the earlier stages of the design of any particular product. It has already disappeared in some cases, and will continue to disappear from the practice of the arts of construction as skill and taste develop. I have already alluded to the abandonment of ornament in the design of machines, and I think there can be no one with any sense of the fit and pleasing who does not approve this change in practice. The stage-coach and horse of former times were lavishly decorated—the carriage of to-day is more graceful and pleasing in virtue of the simple elegance of its lines. In the best domestic architecture of to-day we see the same tendency to trust for effect more and more to an artistic grouping of the lines and masses of essential parts and the gradual abandonment of purely decorative features without and within. There was a time when the hulls and riggings and sails of ships were lavishly ornamented; now even the figurehead—the last remnant of barbaric taste—has disappeared; and do we not find in a full-rigged ship of to-day—or yesterday, perhaps, one should say—a grace and dignity that no extraneous embellishments would enhance? From the racing yacht the designer has been forced, by the demand for efficiency, to cast off every weight and the adornments that so beset the craft of earlier times, with the result that there is left only a beautifully modelled hull, plain masts, and broad sweeps of canvas, and we can hardly imagine any more beautiful or graceful product of the constructive arts. These examples will serve to illustrate the contention that the attainment of the highest efficiency brings with it the greatest artistic merit. But in the development of the yacht of to-day through many stages the designer has been forced from time to time to strive to combine grace with efficiency. Selection on the part of clients must have eliminated ungraceful forms when more beautiful ones could be found, and therefore the advance has been rapid. I think I may appeal to this illustration to support the further contention that advance in efficiency may be helped and not hindered by keeping in view an æsthetic as well as a utilitarian aim. Further illustrations will occur to anyone who has studied the development of design of structures or machines.

It is a matter of constant remark, and with justice, that steel bridges, as a class, are much less pleasing to the eye than those of stone. The reasons for the contrast in artistic merit are not far to seek. The building of stone bridges is an ancient art, and survival of the fittest and selection—even with little creative skill on the part of the designers—would have led to the development of types having, of necessity, at least the elegance of fitness. But, further, this art has come down through the times to which I have referred, when artistic and utilitarian aims had not yet been divorced in the practice of the crafts; and, further still, the practice of building in stone has been in the hands of architects, as well as of engineers, and architects are expected to be artists, and are trained as such. On the other hand, construction in steel is a very modern art, and it has been in the hands of engineers who usually neglect, if they do not despise, the study of the fine arts. But why have architects, with their artistic training, not succeeded in producing artistic structures in steel as admirably as those they design in stone? Partly, no doubt, because they are hampered by tradition. They have not yet fully realized the difference in spirit that must characterize fit designs in the newer and the older materials. No one can be an artist in any material the possibilities and limitations of which he has not fully mastered. Again, if a common engineer may venture the criticism, the architect, as a rule, has not sufficiently mastered the science of construction, and has been too much addicted to taking the easy course of adopting a decorated treatment instead of striving to secure elegance of structural scheme as such; and decoration, at least on anything like traditional lines, is wholly incompatible with the best possibilities of steel as a structural material. Progress is being made in the art of designing efficient and graceful structures in metal, but the best results can only be attained by a designer who has a thorough scientific and technical knowledge of the properties of steel and the processes of its manipulation, on the one hand, and cultured artistic sense and capacity on the other. These should not be considered as appropriate equipments for separate professions.

There are many, however, who have a rooted conviction that structures in steel can never be so beautiful as those in stone. This I believe to be altogether wrong. It arises partly from the crudity of design that characterizes most of the steel structures that have yet been erected, and partly from preconceived notions as to what is fitting in proportions and massiveness. We can quite imagine that a native of the Congo region whose notions of the proportions suitable and comely for a quadruped were founded on his familiarity with the hippopotamus would, at first sight, consider the racehorse sadly lacking in substance and solidity, but in time he might come to recognize some measure of gracefulness in a creature that has been developed to meet requirements that hitherto he had not fully considered.

Mr. Wells has said in his "New Utopia" "the world still does not dream of the things that will be done with thought and steel when the engineer is sufficiently educated to be an artist, and the artistic intelligence has been quickened to the accomplishment of an engineer." But we need not postpone till the advent of a complete Utopia the full realization of our duty to practice our profession as far as in us lies, with due regard for the material interests and æsthetic susceptibilities of all who can be affected by the works for which we are responsible.

The Use of Aluminium for Kitchen and Eating Utensils

THE laboratory of the English medical paper *The Lancet* has recently carried out a series of tests on the applicability of aluminium for eating and drinking utensils. We quote here in full the conclusions arrived at:

"The experiments on the whole show no serious count against aluminium. This metal, at all events, does not appear to be more susceptible to the action of water and foods in the process of cooking than does iron, which has been used from time immemorial as the material of cooking pans. As is well known, iron rusts very readily in the presence of water and air, while also it is attacked by organic acids. It is also well known that iron salts in large quantities are injurious to the organism, as are also large quantities of aluminium salts, as, for example, alum (the double sulphate of aluminium and potassium or ammonium) and aluminium chloride. But there is no evidence to show that in the ordinary cooking operations of everyday practice either iron or aluminium is so strongly attacked as to produce an objectionable amount of soluble salts. All that can be found, when even organic acids and mineral salts are present in the cooking pan, are the merest traces of metal in a soluble state. The alumina precipitated by ammonia in the tests was in practically all cases an unweighable quantity. The case is different when an alkali is present. Carbonate of soda, for example, is without action upon iron, but it certainly attacks aluminium freely, and it would be well to exclude that salt from an aluminium cooking utensil, although even in this case it is doubtful whether any injury to health would be done. The makers of aluminium cooking vessels are fully aware of this action, and, as has been said, they commonly issue a notice warning the possessors of aluminium vessels not to use carbonate of soda, which, after all, is not indispensable to cooking processes.

"A considerable number of experiments has been made concerning the action of water upon aluminium, chiefly in connection with the suggestion that the metal might be used in the making of the water-bottles and mess-tins of the soldier, with the advantage which its lightness would give compared with all other materials hitherto put to similar use. At first the question of expense was a formidable objection to the idea, and later the experiments were unsatisfactory owing to the impurities present in the aluminium early put upon the market. The first objection has disappeared and with it a purer aluminium containing less than 2 per cent of impurities has been commercially produced. At the present time aluminium is universally used in the manufacture of water-bottles for soldiers and other composite bodies of workers. But certain precautions are necessary in order to keep aluminium vessels suitable and hygienic for the purpose, the chief of which is that water should not be left in the bottle when it is not in use. This is in accordance with the findings of our experiments, for it was shown that there is a tendency for wet aluminium to oxidize when left freely in contact with air. It may be desirable, also, not to scour the vessels to such an extent as to remove any thin coating which forms on the surface, for this coating subsequently becomes protective. When not in use it is obvious that aluminium vessels should be kept perfectly dry and free from dust, and a film of hydrocarbon oil effectually protects the metallic surface against the combined action of moisture and air. The same precautions apply equally to iron pots and pans, but in this case it is generally forced upon the attention of the user, as a neglect to keep the pans clean and dry means an unsightly, reproachful, rusty pan. In the experiments recorded we, as a matter of fact, scoured the pans with silver sand for each experiment, which thus exposed a fresh surface each time, so that the conditions were such as to favor a corrosive action, in spite of which no action of serious hygienic importance occurred.

"We are confident that aluminium, as it is now made by reputable manufacturers, is a suitable material for cooking vessels, and that any suspicion that it may communicate poisonous qualities to food in the process of cooking may safely be dismissed in view of the results of the practical experiments which we have recorded, showing that the metal is not appreciably acted upon in cooking operations. This finding is satisfactory also inasmuch as aluminium is an excellent heat conductor, cooking in aluminium vessels is therefore rapid and fuel is economized in consequence. But the management of aluminium cooking utensils requires the same ordinary applications of common sense as are customary in the case of other metals employed for a similar purpose."

The Nineteenth International Congress of Americanists will meet at Washington, D. C., in 1914; probably in the month of September. A second session of the same congress will be held at Le Paz, Bolivia.

WE wish to call attention to the fact that we are in position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical or scientific knowledge required therefor.

We are prepared to render opinions as to validity of, infringement of patents, or with regard to conflicts arising in trade-mark and unfair competition matters.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

MUNN & Co.,
Patent Attorneys.
361 Broadway,
New York, N.

Branch Office:
625 F Street, N. W.,
Washington, D. C.

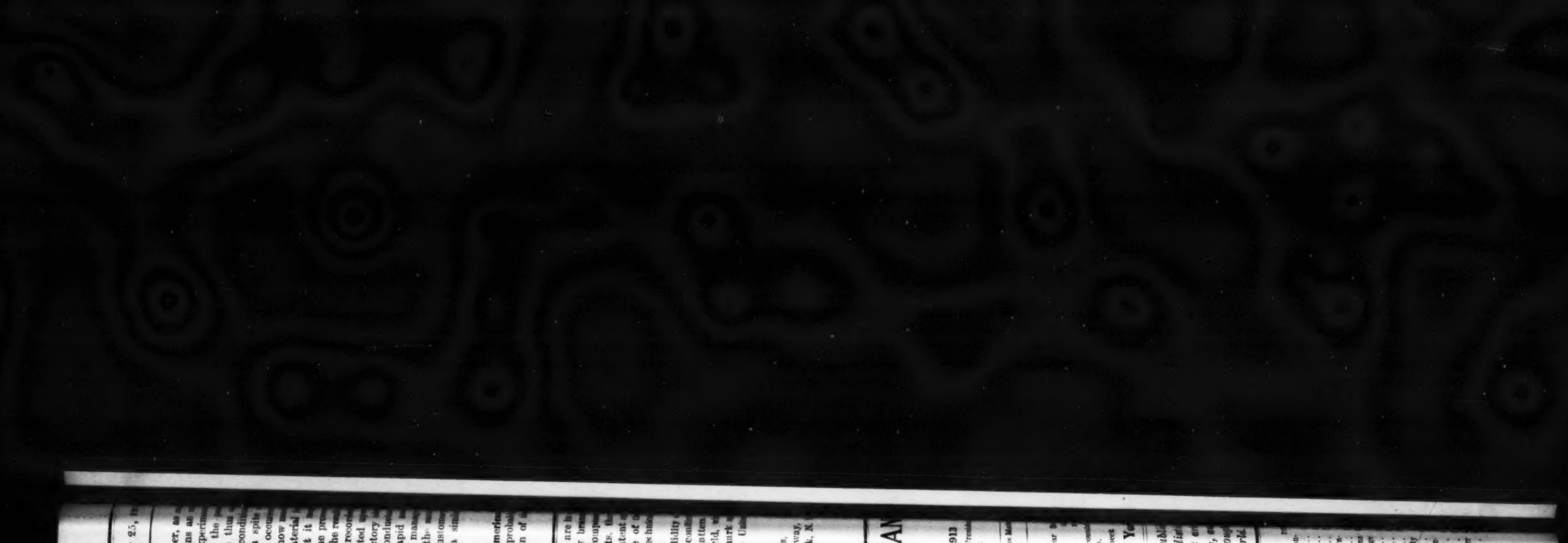
SCIENTIFIC AMERICAN SUPPLEMENT
Founded 1876
NEW YORK, SATURDAY, JANUARY 25, 1913
Published weekly by Munn & Co., Inc., Charles Allen Munn, President; Frederick Converse Beach, Secretary and Treasurer; all at 361 Broadway, New York
Entered at the Post Office of New York, N. Y., as Second Class Matter
Copyright 1912 by Munn & Co., Inc.

The Scientfic American Publications

Scientific American Supplement (established 1876). . per year
Scientific American (established 1845). . . . . "
American Homes and Gardens . . . . . "
The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Table of Contents

The Psychology of the Gambling Habit.—By G. Leonard Corning.—6 illustrations
Suez Canal Not Owned by the British Government
Air Compression
A Fish Out of Water.—By Bashford Dean.—5 illustrations
Greenland's Eden.—By Robert Skerrett.—6 illustrations
Recent Development of the Locomotive.—IV.—By George R. Henderson
The Growth of the Coal Trade.—3 illustrations
Seepage Losses in Irrigation Systems.—22 illustrations
Modern Engineering in an Ancient Eastern Capital.—By F. C. Coleman.—5 illustrations
A German Police Telephone.—By Dr. Alfred Gradenwitz.—5 illustrations
Peroxide in Toilet Preparations
Engineering and the Amenities.—By Prof. Archibald Barr
The Use of Aluminium for Kitchen and Eating Utensils